CARBON DIOXIDE REDUCTION OPTIONS FOR ONTARIO

A DISCUSSION PAPER

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Carbon Dioxide Reduction Options for Ontario:

A Discussion Paper

prepared by

THE CANADIAN INSTITUTE FOR
ENVIRONMENTAL LAW AND POLICY

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Founded in 1970, the Canadian Institute for Environmental Law and Policy (CIELAP) is an independent, not-for-profit research and educational organization. Its mission is to develop and advance proposals for the reform of environmental law and public policy. CIELAP's research is intended to assist government, industry, public interest groups and individuals in their daily decision-making and to further the protection of human health and the preservation of the natural environment.

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Table of Contents

List of Tables

Executive Summary

This report provides a description of 43 policy options and instruments which could be employed to stabilize and then reduce Ontario's carbon dioxide (CO_2) emissions. The objective of the report is provide decision-makers with the potential means to: 1) stabilize Ontario's CO_2 emissions, relative to the 1990 level, by the year 2000; and 2) reduce Ontario's CO_2 emissions by 20%, relative to the 1988 level, by the year 2005. The former target was established by the Framework Convention on Climate Change at the United Nations Conference on Environment and Development in Rio de Janeiro in June 1992. Canada was one of over 150 countries to sign the Convention. The latter was established at the 1988 World Conference on the Changing Atmosphere in Toronto and has been supported by various governments and bodies around the world.

If Ontario is to assist Canada in complying with the terms of the Framework Convention on Climate Change, then it will need to reduce its projected CO_2 emissions by 8751 kilotonnes by the year 2000. If Ontario and/or Canada pursue the 20% reduction target by 2005, then the Province will need to trim its projected CO_2 emissions by 56059 kilotonnes in that year (see Figure I).

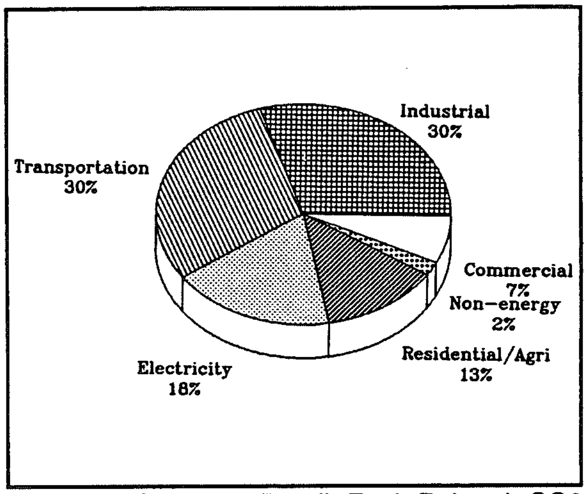


Figure I: Ontario's Fossil Fuel Related CO2 Emissions by Use in 1990. Total CO2 Emissions = 149,839 kilotonnes

This report is composed of three parts. The first part reviews the nature of climate change, existing targets and commitments to reduce greenhouse gases and Ontario's actual and forecast emissions for the year 1990, 2000 and 2005.

The second part of the report deals with options to reduce CO_2 emissions. For the most part, the options are presented sectorally, except for those options which span all or many sectors such as a carbon tax or carbon quota (see Table I below for option examples). The sectors for which options are detailed specifically include the transportation sector, utilities, residential and commercial buildings and the appliance and equipment sector. In most instances options are designed to improve an activity's energy efficiency thereby reducing fossil fuel consumption and its attendant CO_2 emissions.

Some of the options detailed for the transportation sector include higher fuel taxes, road metering, improvements to public transit, encouraging non-car modes of transport, fuel efficiency standards for cars and driver behavioural changes. Options in the utility sector include methods to enhance and expand conservation programs and the means by which the non-utility generation of electricity could be fostered. Options in the building sector include changes to the building code, home energy rating, retrofits, fuel switching and renewable energy. Finally, in the appliance and equipment sector, options include the establishment or enhancement of standards, regulations and labelling programs.

The discussion completes with a summary of the options, their reduction potential and their ability to achieve the targets outlined above. For example, the option of reducing the kilometres driven by the vehicle stock by 5% would reduce CO_2 emissions in the year 2000 by 1600 kilotonnes; this would represent 18% of the reduction needed (8751 kilotonnes) to achieve the 2000 stabilization target. Additionally, four possible CO_2 stabilization and reduction strategies are presented in the final section. These are: 1) A Pure Tax Strategy; 2) A Tax and Carbon Quota Strategy; 3) A Regulatory Policy Strategy; and 4) A Regulatory and Fiscal Policy Strategy.

Table I: Examples of Options Available to Reduce CO_2 Emissions in Ontario

Option to Reduce Carbon Dioxide	**Reduction Achievable in Kilotonnes (kt)**	**% amount that Option contributes to Stabilization**
Retail Sales Tax Extension to Energy	1000 - 2000 kt	11 - 23%
Electrical Rate Increase	2900 - 5700 kt	33 - 65%
100$ to 200$ Carbon Tax	8571 kt	100%
Carbon Quota for Large Industrial Energy Users	7900 kt	90%
Vehicle Stock Reduction: 10%	3200 kt	37%
New Transit Commuters :100,000-500,000	120 - 600 kt	1 - 7%
Higher Fuel Costs	4000 - 6000 kt	46 - 69%
Bicycle Use to Reduce Motor Vehicle Kilometres Driven 5%	1600 kt	18%
CAFC Standards for Cars and Trucks	5150 kt	59%
Utility Conservation Programs Gas Utilities Ontario Hydro	 10000 kt 4000 - 16000 kt	 114% 46 - 182%
Non-utility Generation	8830 - 16370 kt	101 - 187%

Part A : Introduction

1.0 Overview

1.1 Carbon Dioxide Reduction Options for Ontario: A Discussion Paper

The Canadian Institute for Environmental Law and Policy has produced this Discussion Paper to provide the people of Ontario with an analysis of policy options that can be used to: i) stabilize Ontario's carbon dioxide (CO_2) emissions, relative to the 1990 level, by the year 2000; and ii) reduce Ontario's CO_2 emissions by 20%, relative to the 1988 level, by the year 2005.

It is the Institute's hope that the Discussion Paper will help facilitate a consensus with respect to how the Province of Ontario can stabilize and then reduce its CO_2 emissions.

1.2 The Greenhouse Effect, Global Warming and Climate Change

The terms "greenhouse effect", "global warming", and "climate change" are often used interchangeably. Identifying the subtle distinctions between these three terms will help to clarify the climate change issue.[1] The "greenhouse effect" refers to the Earth's atmosphere trapping the sun's warmth in a way similar to the glass of a greenhouse. "Global warming" refers to increasing average global temperature resulting from an increase in greenhouse gases such as carbon dioxide and methane. The increasing concentration of these gases in the atmosphere amplifies the greenhouse effect which offsets the Earth's natural climatic equilibrium, resulting in a net global temperature gain. Finally, "climate change" refers to a wide range of changes in global weather patterns resulting from global warming. Some of the predicted impacts of climate change are:

- a rise in the global mean surface air temperature;
- a rise in sea-levels potentially leading to increased flooding of coastal areas;
- changes in the distribution and seasonal availability of fresh water resources;
- the acceleration of the extinction of animal and plant species through increased habitat stress;
- the alteration of the yield, productivity and biological diversity of natural and managed ecosystems, particularly forests;
- an increase in the number and severity of tropical storms;
- disproportionate temperature increases toward the north and south poles;
- changes in global and regional rainfall and wind patterns; and
- fluctuations in daily and seasonal weather patterns.

According to Environment Canada:

> "Many years of scientific measurements at observing stations in Canada and around the world indicate unequivocally that the atmospheric

concentrations of greenhouse gases are increasing rapidly. By 1990, carbon dioxide and methane concentrations in the global atmosphere had reached values higher than the Earth has seen in more than 160,000 years. The rising concentrations, due to human activities such as burning fossil fuels, various industrial processes, and changing land use, are enhancing the natural greenhouse effect, resulting in additional warming of the Earth's surface."[2]

If few steps are taken to reduce greenhouse gas emissions, a doubling of carbon equivalent concentrations from the pre-industrial level is anticipated by 2025. The Intergovernmental Panel on Climate Change anticipates that a doubling of carbon equivalent concentrations could cause temperature change in the range of 1.9 to 5.2 degrees Celsius, with 2.5 degrees Celsius as the best estimate.

A 1.9 degree Celsius temperature change would be twice the magnitude of the 1 degree Celsius change in European temperatures that heralded the Little Ice Age between the 14th and 17th centuries. The colder temperature induced frequent crop failures and the sporadic freezing of the Baltic Sea. A 5 degree Celsius temperature increase would move the Earth to a climate regime not experienced in over 10 million years.

Perhaps one of the most important impacts to highlight for Ontario is that global temperature increases will be unevenly distributed. Increases of twice the global mean are expected to occur at the earth's poles, therefore Canada will be one of the most affected nations in the world. Possible costly impacts of climate change for Ontario include:

- a drop in Great Lakes' water levels, affecting shipping, drinking water and sewage treatment, port facilities, hydro electric capacity, wetlands, tourism and irrigation;[3]
- migration of forest ecosystems northward, resulting in significant damage to existing forest resources, particularly the northern boreal forest;[4] and,
- human health effects, heat-related stress and illness, breathing and lung disorders from increased air pollution, and increased incidence of skin cancer due to accelerated ozone depletion caused by global warming.[5]

Carbon dioxide, the principal greenhouse gas, is a by-product of fossil fuel consumption. It is responsible for approximately 55% of the strengthening of the greenhouse effect since the industrial revolution.

1.3 The Basis for Action

Despite a near consensus regarding the seriousness of climate change within the scientific community, many jurisdictions have yet to introduce measures necessary to stabilize and reduce their greenhouse gas emissions. There are five important messages that need to be conveyed to the people of Ontario to convince them of the need for, and value of, a carbon dioxide reduction strategy:

1. Climate change is happening as a result of human activity. The increasing emissions of anthropogenic greenhouse gases are upsetting the natural equilibrium of the earth's atmosphere, causing the earth's mean surface air temperature to rise.

2. The consumption of fossil fuels, by increasing the levels of carbon dioxide and methane in the atmosphere, is the major cause of global warming.

3. Ontario individually, or Canada as a whole, each have one of the highest per capita energy consumption levels of any jurisdiction in the world. This is a result of several factors, including energy intensive resource industries, travel distances, historically inexpensive and available sources of energy, and a colder climate compared with virtually all other industrialized nations. Energy consumption per dollar of GNP in Canada is two times greater than most western European countries, and more than one quarter higher than the United States.[6]

4. Unless action is taken to reduce carbon dioxide emissions, the impacts of climate change on the environment, particularly in northern countries, are expected to be severe and irreversible.

5. There are a wide range of specific policy options that Ontario can adopt that will reduce carbon dioxide emissions with no net cost to Ontario's economy. Many of the options will lead to cost-saving benefits for both individuals and society.

The fact that Ontario consumes significantly more energy per capita than virtually all other jurisdictions, suggests that it may have the capability of reducing its energy consumption without altering its standard of living[7]. In fact, a number of jurisdictions with far lower energy consumption per capita than Ontario are committed to reduce their emissions by 20% as outlined in chapter 2.0.

Given the potentially serious consequences of climate change, it would be prudent for Ontario to develop a serious strategy for reducing CO_2 emissions. This report is designed to assist decision-makers in the public and private sectors, consumers, and the public to arrive at such a strategy. By presenting, analyzing, and discussing the options it is hoped that prudent decision-making will be facilitated.

ENDNOTES

1. Environment Canada A Matter of Degrees: A Primer on Global Warming 1993.

2. Climate Change and Canadian Impacts: The Scientific Perspective, Climate Change Digest 91-01, Environment Canada, 1991.

3. Ibid, World Wide Fund for Nature, 1993 and Intergovernmental Panel on Climate Change, 1990.

4. Ibid, World Wide Fund for Nature, 1993 and Intergovernmental Panel on Climate Change, 1990.

5. Ibid, IPCC, 1990, pp 5-40 - 5-49.

6. Chandler, W. U. (Ed.). 1990. Carbon Emissions Control Strategies. World Wildlife Fund & Conservation Fund, Washington D.C.

7. While some of Ontario's high rate of energy consumption may relate to its concentration of energy-intensive natural resource industries, there are a number of areas in which Ontarians and/or Canadians consume more energy for an equivalent activity than many foreign counterparts. For example, single-family electric homes in Sweden use on average approximately 15% less electricity than an equivalent home in Ontario as detailed in "Analysis of Electricity Consumption Data: 1000 House Study" in Proceedings of 1990 Summer Study on Energy Efficiency in Buildings, Vol.2, American Council for an Energy Efficient Economy, 1990. Similarly, the average vehicle fuel consumption rate for vehicles in the City of Toronto was 50% higher than the average of 13 European cities and 30% higher than the average of 5 Australian cities as recently as the mid 1980s as detailed in Cities and Automobile Dependence: An International Sourcebook, 1991, by Newman P. and Kenworth J. While the Canadian average may be approaching the European average it has never matched or surpassed it.

2.0 Review of Existing Targets and Commitments

2.1 International Perspective

Several important national and international commitments and agreements exist requiring jurisdictions to reduce their greenhouse gas emissions. Chief among these is the United Nations Framework Convention on Climate Change (FCCC). This is an international agreement signed by 155 countries at the UN Earth Summit at Rio de Janeiro in 1992. The ultimate objective of the Framework Convention on Climate Change is to stabilize the concentrations of greenhouse gases in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system:

> "achieve...stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner." [1]

In order to stabilize the concentrations of greenhouse gases in the atmosphere, the world's greenhouse gas emissions must be substantially reduced. For example, according to the best scientific evidence, ie. the Intergovernmental Panel on Climate Change, global CO_2 emissions must be reduced by more than 50% in order to stabilize the concentrations of greenhouse gases in the atmosphere at their present level[2].

As a first step towards the achievement of its ultimate objective, the Convention requires its signatories, including Canada, to stabilize their greenhouse gas emissions, excluding chlorofluorocarbons (CFC) emissions, at their 1990 levels by the year 2000[3].

The Convention has not established a timetable for the emission reductions which must occur after the year 2000 in order to stabilize the concentration of greenhouse gases in the atmosphere and prevent dangerous interference with the climate system. However, in 1988, the Toronto Conference on The Changing Atmosphere: Implications For Global Security (the Toronto Conference) recommended that CO_2 emissions should be reduced by approximately 20%, relative to the 1988 level, by the year 2005 and eventually by 50% or more.

Table 2.1 lists countries that have adopted targets that go beyond a commitment to stabilize greenhouse gas emissions.

Table 2.1 National CO_2 Reduction Targets Beyond Stabilization

Country	Target	Year	Support
Australia	20% CO_2 reduction	2005	weak
Austria	20% CO_2 reduction	2005	strong
Canada*	20% CO_2 reduction	2005	moderate
Denmark	20% CO_2 reduction	2005	strong
Germany	25% CO_2 reduction	2005	strong
Luxembourg	20% CO_2 reduction	2005	strong
Netherlands	2-3% CO_2 reduction	2000	strong

* The Minister of the Environment for Canada has stated that the Government of Canada supports the objective of a 20% reduction in CO_2 emissions by 2005. However, the Government of Canada has not made a binding commitment to achieve this target by 2005.

Source: Independent Evaluations of National Plans for Climate Change Mitigation, US Climate Action Network and Climate Network Europe, February, 1994.

The countries that have adopted CO_2 reduction targets also have some of the highest standards of living in the world. The primary distinction between Canada and the European countries listed, is that Canada's per capita energy consumption is significantly greater, leaving much more room for improvement in energy efficiency than is available in most of the European countries. Theoretically it should be much easier for Canada to reach the 20% CO_2 reduction target than, say, Denmark.

2.2 Canada

The Government of Canada is committed to stabilizing Canada's greenhouse gas emissions, at the 1990 level, by 2000.

In addition, the Government of Canada supports the objective of reducing Canada's CO_2 emissions by 20% by 2005. According to the Honourable Sheila Copps, Deputy Prime Minister and Minister of the Environment:

> "The Canadian government supports the objective of cutting carbon dioxide emissions by 20% from 1988 levels by the year 2005."[4]

However, it is important to note that the Government of Canada has not made a binding commitment that Canada will actually reduce its CO_2 emissions by 20% by 2005.

There are at least three reasons why Canada may have difficulties reaching its stabilization and 20% reduction targets:

Canada's CO_2 emissions are expected to increase 10.6% by 2000 in a "business as usual" scenario.

The federal government does not have exclusive jurisdiction over many of the policy options that will need to be implemented to ensure that the targets are reached; and,

There will be vigorous opposition from certain industry sectors regarding some of the actions that the federal government may choose to take.

order to overcome these difficulties, the federal, provincial and territorial Ministers of vironment and Energy have initiated a major multi-stakeholder process. The process s under the auspices of the Canadian Council of Ministers of the Environment (CCME) d the Council of Energy Ministers and specifically the National Air Issues Coordinating mmittee (NAICC). The NAICC is a multi-stakeholder process charged with reviewing wide range of air emission issues, not just climate change. One of the specific jectives of the NAICC is to coordinate federal and provincial action plans and create National Action Program on Climate Change.

e NAICC has been instructed to:

"proceed with the development of options that will meet Canada's current commitment to stabilize greenhouse gas emissions by the year 2000 and to develop sustainable options to achieve further progress in the reduction of emissions by the year 2005.[5]

ithin the NAICC there is a management process for addressing climate change issues iown as the Climate Change Task Group (CCTG). A list of possible measures for the ational Action Plan on Climate Change has been prepared by the Measures Working roup of the CCTG.[6]

2.3 Ontario

e Government of Ontario, like the Government of Canada, is committed to stabilizing ntario's greenhouse gas emissions, at the 1990 level, by the year 2000.

irthermore, on June 9, 1994 the Legislative Assembly of Ontario endorsed the vernment of Canada's commitment to reduce Canada's greenhouse gas emissions by %, relative to the 1988 level, by 2005:

"Therefore this assembly supports the federal government in its commitment to a 20% reduction in Canada's greenhouse gas emissions over 1988 levels by 2005, and further supports leadership on the part of Ontario in helping to develop and implement a national action plan to achieve this environmentally imperative goal."[7]

According to the Honourable Bud Wildman, Ontario's Minister of Environment and Energy, the Government of Ontario is "working to take Ontario as quickly as feasible to stabilizing greenhouse gas emission levels and to a 20% reduction and beyond."[8] However, it is important to note that the Government of Ontario has not made a binding commitment to reduce Ontario's CO_2 emissions by 20% by a specific date.

Ontario is one of the most important jurisdictions in Canada for demonstrating leadership and policy direction to reduce CO_2 emissions, primarily because one-third of Canada's CO_2 emissions are generated in Ontario.[9]

There are many private and public organizations that may be able to assist the Ontario government in developing a CO_2 reduction action plan and achieving a 20% CO_2 reduction. Ontario Hydro and the Ontario Round Table on Environment and Economy are two public sector bodies well-positioned to assist the province.

Ontario Hydro has made commitments to the principles of sustainable development and has in its mandate plans to make Ontario the most energy efficient jurisdiction in the world. These objectives, if implemented, would be consistent with a carbon dioxide reduction strategy.

Ontario Hydro is engaged in two processes that may be able to dovetail with provincial plans for reducing CO_2 emissions. First, is the Private/Public Energy Efficiency Consortium which has a mandate to develop an action plan for making Ontario more energy efficient. Second, is the Strategy for the Management of Greenhouse Gas Emissions, which includes external stakeholder consultations with Ontario Hydro to review GHG emission strategies.[10]

The Ontario Round Table on Environment and Economy is an advisory body to the Premier of Ontario. Its mission is to develop sustainable development strategies for Ontario. The Round Table's membership consists of provincial cabinet ministers, industrialists, academics, environmentalists, labour and community leaders. The Round Table could have an important role as a facilitator of a consensus-driven process to develop an Ontario Climate Change Action Plan. It has recommended the following targets and timetables for reducing greenhouse gas emissions:

Table 2.2 Ontario Round Table Recommended Targets

Target	Year
Stabilize GHG Emissions	2000
20% CO_2 reduction	2005
70-80% CO_2 reduction	2030
80% global fossil fuel reduction	2030

Source: Ontario Round Table, Restructuring for Sustainability, 1992.

2.4 Corporate Commitments

In a survey administered by the Canadian Institute for Environmental Law and Policy, over 60% of the corporate respondents surveyed support provincial stabilization policies, and over 45% support a 20% reduction. In both cases, less than 20% of responses opposed policies to reduce carbon dioxide emissions in Ontario.

A number of corporations in Ontario have exemplary records and have adopted either stabilization or the 20% CO_2 reduction as their corporate targets. Five major corporations in Ontario have strategies in place to reduce their CO_2 emissions 20% by 2005. These companies are Honda, Molsons, North American Life, Domtar, and Inco.

Ontario cannot meet any targets without the cooperation and active participation of the private sector. It is encouraging to see that a number of willing partners have already emerged.

2.5 Summary

The exercise of outlining policy options available to the province is intended to provide preliminary information upon which the province can begin to build a more detailed CO_2 reduction strategy. Many of the options required to institute a carbon dioxide reduction strategy will require legislative and policy amendments by the provincial and federal governments, therefore there will need to be a high degree of involvement in and support of the process by the Governments of Ontario and Canada.

ENDNOTES

1. United Nations Framework convention On Climate Change, Article 2

2. World Meteorological Organization/United Nations Environment Programme, Scientific Assessment of Climate Change: The Policymakers' Summary of the Report of Working Group I to the Intergovernmental Panel on Climate Change, (1990), pp. 9-12.

3. Framework Convention On Climate Change, Article 4. CFC emissions are controlled by the Montreal Protocol.

4. Letter from the Honourable Sheila Copps to Louise Comeau, Sierra Club, Ottawa, February 10, 1994.

5. Ibid.

6. Climate Change Task Group of the National Air Issues Co-ordinating Committee, Draft Outline National Action Programme on Climate Change, June 1994.

7. Legislative Assembly of Ontario, Third Session, 35th Parliament, Official Report of Debates (Hansard), 9 June 1994, pp. 6757, 6772

8. Memorandum to Members of Externalities Collaborative from Helmuth Shumann, Ontario Ministry of Environment and Energy, April 22, 1994

9. *Ibid,* Environment Canada, 1994, p 96.

10. Ontario Hydro, Memorandum on Ontario Hydro's Greenhouse Gas Emissions, from Brian Kelly, April, 1994.

3.0 Ontario's Carbon Dioxide Emissions: Actual and Forecast

3.1 Ontario's Carbon Dioxide Emissions

Ontario's net carbon dioxide emissions in 1990 equalled 147,839 kilotonnes.[1] Ninety-seven percent (97%) of these emissions were due to the consumption of fossil fuels. The remaining 3% is mainly the result of cement and lime production. Table 3.1 shows Ontario's 1990 fossil fuel-related CO_2 emissions in kilotonnes by fossil fuel and use.

Table 3.1: Ontario's Fossil Fuel-Related CO_2 Emissions in 1990 (kilotonnes)

	Oil	Natural Gas	Liquid Petroleum Gases	Coal	TOTAL
Residential and Agriculture	5,297	12,958	306	0	18,561
Commercial	2,210	7,400	299	0	9,909
Industrial	10,323	19,155	567	13,015	43,060
Transportation	42,129	39	646	0	42,814
Electricity Generation	1,059	420	0	24,623	26,102
Non-Energy	2,500	693	330	290	3,813
TOTAL	63,318	40,665	2,148	38,128	144,259

Source: Economic and Financial Analysis Branch, Energy Sector, Natural Resources Canada.

Figures 1 and 2 provide percentage break-outs of Ontario's 1990 fossil fuel-related carbon dioxide emissions by: a) fossil fuel; and b) use.

Figure 1: Ontario's 1990 Fossil Fuel Related CO_2 Emissions By Fuel

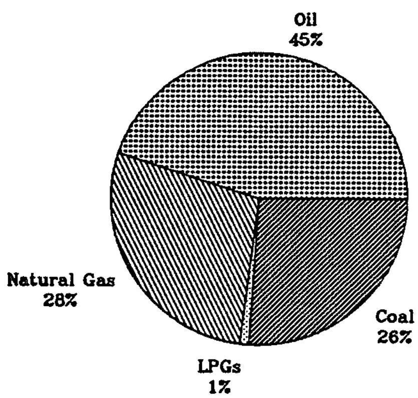
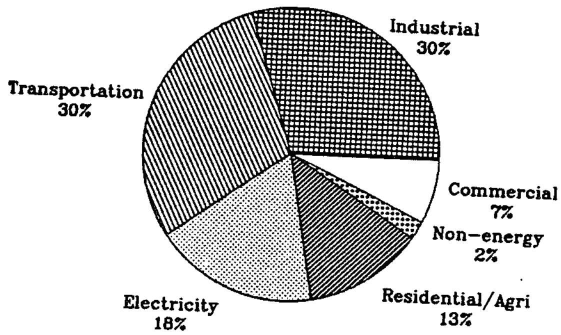
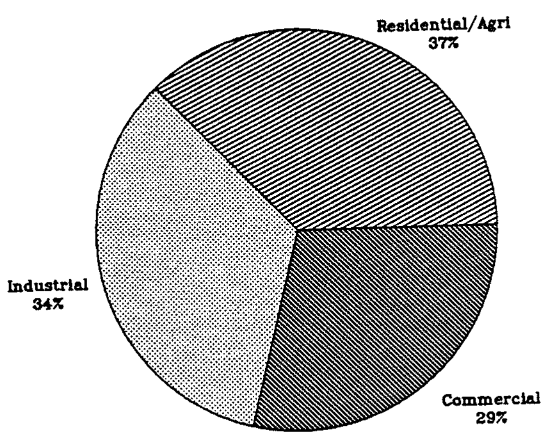


Figure 2: Ontario's 1990 Fossil Fuel Related CO_2 Emissions By Use



According to Table 3.1, electricity generation was responsible for 18% of Ontario's fossil-fuel related CO_2 emissions in 1990. Figure 3 provides a break-out of Ontario's electricity consumption by consuming sector in 1990. Table 3.1 and Figure 3 can be used to calculate Ontario's fossil fuel-related CO_2 emissions by sector due to electricity consumption. For example, in 1990 the industrial electricity consumption was responsible for 6% of Ontario's fossil fuel-related CO_2 emissions (18% x .34).

Figure 3 Ontario's electricity consumption by consuming sector in 1990.



Projection for 2000

Table 3.2 shows Natural Resources Canada's best estimates of Ontario's fossil fuel-related CO_2 emissions in 2000 if no additional steps are taken by the Governments of Canada and Ontario to stabilize or reduce Ontario's CO_2 emissions.[2] According to these estimates, Ontario's total fossil fuel-related CO_2 emissions in 2000 will be 6.5% higher than the 1990 level. However, the CO_2 emissions due to the use of oil by the residential and agriculture, commercial, and industrial sectors are projected to decline by 11%. Moreover, CO_2 emissions related to the generation of electricity from coal are projected to decline by 66%.

Table 3.2: Ontario's Projected Fossil Fuel-Related CO_2 Emissions in 2000 (kilotonnes)

	Oil	Natural Gas	Liquid Petroleum Gases	Coal	TOTAL
Residential and Agriculture	4,279	14,645	364	0	19,288
Commercial	2,695	9,423	410	0	12,528
Industrial	10,103	25,399	1001	17,100	53,603
Transportation	47,378	117	777	0	48,272
Electricity Generation	1,402	3,684	0	8,289	13,375
Non-Energy	3,302	846	1081	317	5,546
TOTAL	68,886	54,114	3,633	25,389	152,612

Source: Economic and Financial Analysis Branch, Energy Sector, Natural Resources Canada.

On the other hand, according to Ontario Hydro's most recent forecast, electricity-related CO_2 emissions in 2000 will be 24,800 kilotonnes. That is, according to Hydro, electricity-related CO_2 emissions in 2000 will be only 5% less than their 1990 level.[3]

Projection for 2005

Table 3.3 shows Natural Resources Canada's best estimates of Ontario's fossil fuel-related CO_2 emissions in 2005 if no additional steps are taken by the Governments of Canada and Ontario to stabilize or reduce Ontario's CO_2 emissions.[4] According to these estimates, Ontario's total fossil fuel-related CO_2 emissions in 2005 will be 18% higher than the "business as usual" estimate for 2000 and 26% higher than the actual level of emissions in 1990. According to these estimates, only Ontario's CO_2 emissions, related to the use of oil and liquified petroleum gases in the residential and agricultural sectors, will decline between 2000 and 2005. Furthermore, according to these projections, electricity-related CO_2 emissions will increase by 90% between 2000 and 2005. However, if Ontario Hydro's forecast of electricity-related CO_2 emissions in 2000 is correct, electricity-related CO_2 emissions will only increase by approximately 3% between 2000 and 2005.

Table 3.3: Ontario's Projected Fossil Fuel-Related CO_2 Emissions in 2005 (kilotonnes)

	Oil	Natural Gas	Liquid Petroleum Gases	Coal	TOTAL
Residential and Agriculture	4,091	15,056	358	0	19,505
Commercial	3,013	10,601	468	0	14,082
Industrial	11,778	27,744	1091	19,425	60,038
Transportation	54,056	161	867	0	55,084
Electricity Generation	3,937	4,631	0	16,889	25,457
Non-Energy	3,545	948	1081	348	5,922
TOTAL	80,420	59,141	3,865	36,662	180,088

Source: Economic and Financial Analysis Branch, Energy Sector, Natural Resources Canada.

The Emissions Gap

Table 3.4 shows Ontario's actual or projected CO_2 emissions in 1988, 1990, 2000, and 2005.

Table 3.4: Ontario CO_2 Emissions (kilotonnes)

Year	CO_2 Emissions in kilotonnes	Actual/Projected
1988	160,704	Actual
1990	147,839	Actual
2000	156,590	Projected
2005	184,622	Projected

Source: Economic and Financial Analysis Branch, Energy Sector, Natural Resources Canada

If the Natural Resources Canada projections are correct, Ontario's projected CO_2 emissions must be reduced by 8751 kilotonnes (5.6%) in 2000 and 56,059 kilotonnes (30.4%) in 2005 in order to: i) stabilize Ontario's CO_2 emissions by 2000 relative to the 1990 level; and ii) reduce Ontario's CO_2 emissions in 2005 by 20% relative to the 1988 level.

On the other hand, if Ontario Hydro's forecast of electricity-related CO_2 emissions in 2000 is correct, Ontario must reduce its projected CO_2 emissions by 20,176 kilotonnes (12.3%) in 2000.

ENDNOTES

1. Assuming that Ontario's net biomass-related carbon dioxide emissions are zero.

2. Natural Resources Canada, Canada's Energy Outlook 1992 - 2020, (September 1993), p. 1. The Natural Resources Canada forecast served as the basis for Canada's National Report on Climate Change (1994).

3. Don Power, Power Resources Planning, Grid System Strategies and Planning, Ontario Hydro, Ten Year Capacity and Energy Summary - Revision (April 13, 1994).

4. Natural Resources Canada, Canada's Energy Outlook 1992 - 2020, (September 1993), p. 1.

Part B: Review of Policy Options

Policy Options Overview

The second part of this report describes options which could be implemented, primarily by government, to avert or reduce the effect of climate change created by the emission of carbon dioxide. There are four basic policy instruments available to government:

1. Fiscal Policy - for example the use of taxes, tax exemptions and government expenditures.

2. Regulatory Policy - which might include minimum energy efficiency standards, product bans, CO_2 emission quotas or public utility regulation.

3. Public Education - for example, information on how homeowners could reduce their energy consumption.

4. Moral Suasion - which might involve persuading large energy consumers to voluntarily reduce their CO_2 emissions.

According to a Royal Society of Canada report, a 20% reduction in CO_2 emissions relative to the 1990 level by 2010, is cost-effective and worth doing even if climate change were not an issue.[1] The report also concludes that even though this potential is cost-effective, it will still require government policy to make the changes happen. Without targets, timetables and concrete policies to reduce greenhouse gases, the potential will not be met.

The following chapters of Part B will detail the various options available to the public and private sectors that could be adopted to achieve the CO_2 reduction targets of stabilization and 20% reduction.

In Part C, following this section, the options are summarized in Table 11.1 and related to the targets of stabilization and 20% reduction. As well the options are related to four potential strategies which could be pursued to meet the targets.

4.0 Tax Options

4.1 Introduction

There are two fundamental tax options available to the Government of Ontario to reduce Ontario's CO_2 emissions, namely: 1) remove the existing financial subsidies for energy consumption; and 2) establish a system of energy or carbon taxes.

The Government of Ontario directly subsidizes energy consumption in a number of quantifiable ways, including: 1) exempting energy from the retail sales tax; 2) not requiring motor vehicle users to pay the full costs of road construction, policing and vehicle-related medical costs; 3) not requiring Ontario Hydro to pay a market-based fee for the use of Ontario's water resources (e.g., a fee which reflects the market value of Niagara Falls); 4) exempting Ontario Hydro from the provincial corporate income tax; 5) not requiring Ontario Hydro to earn a market rate of return on its assets. Furthermore, Ontario Hydro is exempt from the federal corporate income tax.

If these financial subsidies were eliminated the price of energy would rise and Ontarians would have a greater financial incentive to conserve energy. The resulting decline in energy consumption would lead to a decline in Ontario's CO_2 emissions.

The Government of Ontario also indirectly subsidizes energy consumption by not requiring consumers to pay the full environmental costs of their energy use (e.g., urban smog, acid rain, toxic air pollution, global warming). These subsidies could be eliminated by the establishment of pollution taxes. For example, the Government of Ontario could establish a carbon tax which would require consumers to pay a portion or all of the environmental costs of their CO_2 emissions. A carbon tax is an energy tax that varies in proportion to a fossil fuel's carbon content (e.g., if the carbon tax for natural gas is $1 per gigajoule (GJ), it would be $1.30 for oil and $1.95 for coal).

The tax revenues realized through eliminating the energy subsidies or establishing a carbon tax can be used to reduce the rates of one or more of Ontario's existing taxes (e.g., reducing the retail sales tax from 8% to 6%). If 100% of the revenues from the new taxes are used to offset existing taxes, the reform of Ontario's tax system will be revenue-neutral. That is, it will not increase the total tax burden for Ontario residents and businesses.

4.2 Retail Sales Tax

According to Natural Resources Canada's projections, Ontario's 1994 residential expenditures for electricity, natural gas and oil will be $4.0 billion, $1.7 billion and $421 million respectively. Furthermore, Ontario's 1994 commercial sector expenditures for electricity, natural gas and oil are projected to be $4.4 billion, $803 million and $146 million respectively.

Thus Ontario's total 1994 residential and commercial sector expenditures for electricity, natural gas and oil are projected to be approximately $11.5 billion. Therefore a provincial sales tax of 8% on residential and commercial sector electricity, natural gas and oil consumption would yield annual revenues of approximately $920 million for the Government of Ontario.[2]

Assuming Natural Resources Canada's estimates of Ontario's energy prices and consumption in 2000 and 2005 and a range of estimates of the impact of price increases on energy consumption, eliminating the retail sales tax exemption for energy would reduce Ontario's carbon dioxide emissions by 1000 to 2000 kilotonnes in 2000 and by 2200 to 4200 kilotonnes in 2005.[3]

4.3 Motor Vehicle Subsidies

According to a Pollution Probe report, The Costs Of The Car, in 1990 the Government of Ontario's revenues from gas taxes, car and truck registration fees and the tire tax was approximately $2 billion. Furthermore, the revenue from federal gas taxes paid by Ontario drivers was approximately $880 million. That is, in 1990, Ontario drivers paid approximately $2.9 billion in taxes for the use of Ontario's roads.[4]

On the other hand, according to the Pollution Probe report, in 1990, the expenses of the federal, provincial and municipal governments with respect to the use of motor vehicles in Ontario (i.e., road construction and maintenance, health care and policing) were approximately $4.5 billion.[5]

Therefore in 1990 motor vehicle users received an annual taxpayer-financed subsidy of approximately $1.6 billion. This subsidy could be eliminated by reducing government expenditures on road construction, raising gasoline taxes, establishing a provincial tax on parking lots and/or instituting road tolls. However, the ability of the Government of Ontario to raise gasoline taxes in communities near provincial and international borders will be constrained by the level of gasoline taxes in neighbouring jurisdictions.

The impact of higher gasoline taxes, parking taxes and/or road charges on CO_2 emissions would be critically dependent on the quality (in terms of speed and comfort) of the public transit alternatives. The quality of the public transit alternatives could be enhanced by ear-marking some or all of the incremental gasoline, parking or road toll revenues for the construction and operation of public transit systems.

4.4 Ontario Hydro

According to a report prepared for the federal government, Blue Gold: Hydro-Electric Rents in Canada, the market value of the province's water resources that are used by Ontario Hydro to generate electricity was $753 million in 1979.[6] Adjusting for inflation $753 million in 1979 is equivalent to $1.4 billion in 1992.[7] However, in 1992 Ontario Hydro's water rental payments to the Government of Ontario were only $109 million.[8] In effect, Ontario Hydro received a water rental subsidy of approximately $1.3 billion in 1992.

In 1992 Ontario Hydro's real rate of return on capital was only 4.6%.[9] On the other hand, the average rate of return of investor-owned Canadian corporations is 9%.[10] If Ontario Hydro had been required to earn a 9% real rate of return on its capital in 1992, its costs would have been $2 billion higher.[11]

Thus, in the absence of the above noted water and rate of return on capital subsidies, Ontario Hydro's 1992 rates would have been 43% higher.[12] [13]

Assuming Natural Resource Canada's estimates of Ontario's energy consumption in 2000 and 2005 and traditional estimates of the impact of price increases on energy consumption, a tax that raises Ontario Hydro's rates by 43% in 2000 and 2005 would reduce Ontario Hydro's carbon dioxide emissions by approximately 2900 to 5700 kilotonnes in 2000 and by approximately 6000 to 12,000 kilotonnes in 2005.[14]

If 100% of the tax revenues which result from eliminating these subsidies to Ontario Hydro are used to reduce existing Ontario taxes, eliminating the Hydro subsidies will not increase the total tax burden for the average Ontario resident or business. However, eliminating the Hydro subsidies will increase the net tax burden for Ontario's electricity-intensive industries (i.e., the industries that are the prime beneficiaries of the Hydro subsidies).

The adjustment cost to Ontario's electricity-intensive industries, as a result of eliminating the Hydro subsidies, could be mitigated or eliminated if: i) the electricity subsidies are phased-out over a 5 to 10 year period; ii) Ontario Hydro enhances its energy efficiency programmes that reduce the electricity bills of its electricity-intensive industrial customers, and/or iii) Hydro encourages and facilitates the co-generation of electricity by Ontario's electricity-intensive industries.

4.5 A Carbon Tax

Magnitude of the Carbon Tax

A carbon tax could be used to stabilize Ontario's CO_2 emissions by 2000 and achieve a 20% reduction by 2005.

A number of Canadian and U.S. studies have estimated the level of carbon taxation necessary to achieve the stabilization and 20% reduction targets:

1. according to a 1992 Federal Department of Finance study, a carbon tax of $98 (1990$) per tonne would be required to stabilize Canada's CO_2 emissions by 2000;[15]

2. according to a 1993 DRI/McGraw-Hill report for the Federal Government, a carbon tax of $150 (1990$) would be required to stabilize Canada's greenhouse gas emissions at their 1990 level by 2000;[16]

3. according to the 1992 Department of Finance study, a carbon tax of approximately $490 (1990$) per tonne would be required to reduce Canada's CO_2 emissions by 20% by 2000;[17]

4. according to a 1991 DRI/McGraw-Hill report for Imperial Oil, a carbon tax of $200 (1993$) per tonne would be required to reduce Canada's CO_2 emissions by 20% by 2005;[18]

5. U.S. studies have estimated that a carbon tax of between $50 to $330 (1990$ U.S.) per tonne would be required to reduce the United States CO_2 emissions by 20% by 2010.[19]

All of the above carbon tax estimates are based on the assumption that a carbon tax would be the <u>only</u> policy instrument used to achieve the CO_2 targets. Needless to say, if a carbon tax is complemented by other instruments (e.g., minimum energy efficiency standards for cars and appliances) the required magnitude of the carbon tax would be less.

In light of the above, it appears reasonable to assume that a carbon tax of between $100 and $200 (1994$) per tonne could stabilize Ontario's CO_2 emissions by 2000 and achieve a 20% reduction by 2005. A carbon tax of $100 to $200 per tonne could be phased-in gradually over the next 10 years. For example, a carbon tax of $100 ($200) per tonne could be phased-in at the rate of $10 ($20) per tonne per year. Under this scenario the carbon tax rate (1994$) in 1994, 2000 and 2003 would be $10 ($20), $70 ($140) and $100 ($200) respectively. Furthermore the carbon tax revenues of the Government of Ontario would be approximately $370 to $743 million in 1994 and approximately $3.5 to $7 billion (1994$) in 2005.[20] Carbon tax revenues of $3.5 to 7 billion would be equivalent to approximately 7.5% to 15% of the Government of Ontario's total expenditures in 1993/94.

Impact of Carbon Tax on Energy Prices

As Table 4.1 indicates a carbon tax would cause: 1) the price of coal to rise more than the price of oil or natural gas; 2) industrial prices to rise more than commercial and residential prices; 3) residential natural gas prices to rise more than gasoline prices; and 4) the price of gasoline to rise more than the price of electricity. The reasons for the varying price impacts of a carbon tax are as follows. First, since the carbon content of a GJ of coal is higher than that of a gigajoule of oil and gas, a carbon tax has a greater price impact on coal than oil or gas. Second, since industrial energy prices have smaller distribution mark-ups per GJ than commercial and residential prices, a carbon tax will have a greater percentage impact on industrial prices. Third, since gasoline is already subject to significant excise taxes and natural gas is not, a carbon tax will have a greater price impact, in percentage terms, on natural gas than gasoline. Fourth, since the cost of fossil fuels is responsible for only 8% of the total cost of electricity, a carbon tax will have a relatively small impact on the price of electricity.[21]

Table 4.1: Impact of Carbon Taxes on Energy Prices

	$10/tonne Carbon	$100/tonne Carbon	$200/tonne of Carbon
Residential Price Electricity	+ 0.7%	+ 6.7%	+13.4%
Residential Price : Natural Gas	+ 2.1%	+21.3%	+42.6%
Residential Price : Light Fuel Oil	+ 2.0%	+19.7%	+39.4%
Residential Price : LPGs	+ 1.1%	+10.9%	+21.8%
Gasoline	+ 1.1%	+11.4%	+22.8%
Coal	+ 15.1%	+ 150.6%	+ 301.2%
Commercial Price : Electricity	+ 0.6%	+ 5.5%	+11.0%
Commercial Price : Natural Gas	+ 2.8%	+28.2%	+56.4%
Commercial Price : Light Fuel Oil	+ 2.1%	+21.0%	+42.0%
Industrial Price : Electricity	+ 1.0%	+ 9.7%	+19.4%
Industrial Price : Natural Gas	+ 3.8%	+38.4%	+76.8%
Industrial Price : Heavy Fuel Oil	+ 4.9%	+49.0%	+98.0%

Impact on GDP

The 1992 Department of Finance and the 1991 DRI/McGraw-Hill studies concluded that carbon taxes would allow Canada to simultaneously achieve significant CO_2 reductions and significant increases in GDP. However, according to these studies, Canada's GDP would be slightly higher in the absence of a carbon tax.

According to the Department of Finance study a carbon tax which stabilized Canada's CO_2 emissions by 2000 would only reduce our forecast GDP in 2000 by 1/2 of 1%.[22] In other words, according to this study, Canada could simultaneously stabilize its CO_2 emissions and achieve a 14% increase in real GDP per capita (i.e., real living standards would rise by 14% per person) between 1990 and 2000.[23]

According to the same study, a carbon tax which achieved a 20% reduction in Canada's CO_2 emissions by 2000 would reduce Canada's forecast real income in 2000 by approximately 2.3%.[24] That is, Canada could simultaneously achieve a 20% reduction in CO_2 emissions and achieve a 12% increase in real GDP per capital between 1990 and 2000.[25]

According to the 1991 DRI/McGraw-Hill report, a carbon tax which reduces Canada's CO_2 emissions by 20% by 2005 would reduce Canada's GDP in 2005 by about 4/10ths of 1%.[26] Thus, according to the DRI report, Canada could simultaneously achieve a 20% reduction in CO_2 emissions and a 30% increase in real GDP per capita between 1990 and 2005.[27]

The 1991 DRI and 1992 Department of Finance studies did not assume that the carbon tax revenues would be used to reduce other taxes. On the contrary, they assumed that the revenues would be used to reduce the federal deficit, increase government spending or to provide lump sum payments to Canadian citizens (e.g., an annual rebate cheque to each citizen equal to the total carbon tax revenues divided by the number of Canadian citizens).[28] If the carbon tax revenues are used to reduce taxes which penalize effort or investment (e.g., personal or corporate income taxes) the net impact of a system of carbon taxes on Canada's GNP could be positive.[29] [30]

According to D.W. Gaskius and J.P. Weyant, if the revenues from a U.S. carbon tax were used to reduce the rates of existing taxes, 35% to more than 100% of the GDP losses would be offset.

> "The way in which carbon-tax revenues are used has an important impact on the projected GDP loss. The projected GDP losses could be reduced substantially (relative to those calculated for the lump-sum recycling case) by using the carbon-tax revenues to reduce existing taxes that discourage economic activity, particularly capital formation. Simulations with four models of the U.S. economy indicate that from 35 percent to more than 100 percent of the GDP losses could ultimately be offset by recycling revenues through cuts in existing taxes."[31]

Finally, according to William Nordhaus, if the revenues from a global carbon tax are used to reduce existing tax rates, the global economy could simultaneously achieve a 20% reduction in CO_2 emissions and a $200 billion increase in global output.[32]

Impact on Energy-Intensive Industries

As noted above, a revenue-neutral carbon tax could have a positive impact on Ontario's economy as a whole since the negative impact of the carbon tax could be more than offset by the positive impact of lower personal or corporate income taxes or both. However, a carbon tax would impose a net tax burden on Ontario's energy-intensive industries since the energy bills of these industries is much higher than the provincial average. As Table 4.2 indicates, energy expenditures as a percentage of value of shipments is 4.7%, 5.5%, 9.6% and 20.4% for Ontario's chemical, mining, pulp and paper and cement industries respectively; whereas it's only 2.2% for the average manufacturer. That is, for Ontario's energy-intensive industries the rise in their energy bills would exceed the reduction in their income and/or payroll taxes.

Table 4.2: Ontario Energy Intensity and Employment Statistics for Selected Manufacturing Industries, 1986.

	Energy Expenditures as a % of the Value of Shipments	Employment	Employment as a Percent of Total Ontario Employment
All Manufacturing	2.2%	934,918	20.67%
Cement	20.4%	1,277	0.03%
Chemical & Chemical Products	4.7%	50,722	1.12%
Food & Beverages	1.7%	86,885	1.92%
Mining	5.5%	24,602	0.54%
Primary Metals	5.4%	62,429	1.38%
Pulp and Paper	9.6%	19,942	0.44%

Source: Statistics Canada Catalogues 31-201, 31-203

If Ontario and its major trading partners (i.e., other Canadian provinces and the U.S.) simultaneously introduce comparable carbon taxes, the output and employment impacts of a carbon tax on most of Ontario's energy-intensive industries would be manageable. However, if Ontario's carbon tax is significantly higher than the carbon tax of one or more of its major trading partners, the Ontario carbon tax could have a significant negative impact on Ontario's energy-intensive industries that are subject to interprovincial or international competition (e.g., Stelco).

Furthermore, even if Ontario and the U.S. were to have comparable carbon taxes, an Ontario carbon tax could have very negative implications for an energy-intensive Ontario industry if it has competitors located outside of Ontario and the U.S. that are not subject to a comparable carbon tax.

Finally, a decline in the output of Ontario's energy-intensive industries would not lead to a decline in global CO_2 emissions if the Ontario output is displaced by non-Ontario companies whose CO_2 emissions per unit of output are greater than or equal to those of Ontario manufacturers.

Impact on Low Income Families

Energy expenditures as a percentage of total expenditures (total consumption, taxes and savings) decline as incomes rise. As Table 4.3 indicates, in 1986, energy expenditures accounted for 6.1% of the total expenditures of families with incomes under $10,000; whereas they accounted for 4.7% of the total expenditures of families with incomes in excess of $50,000. As a result, everything else being equal, low income families would experience the greatest percentage decline in disposable income (total income minus taxes) if a carbon tax is introduced. However, there are numerous ways in which the negative impact of a carbon tax could be completely offset.

Table 4.3: Family Expenditure by Family Income. Ontario 1986.

	Under $10,000	$10,000 to $19,999	$20,000 to $29,999	30,000 to $39,999	$40,000 to $49,999	$50,000 and over	All Classes
Energy Expenditure	$ 589	$ 1,110	$ 1,468	$ 1,960	$ 2,319	$ 3,082	$ 1,974
Total Expenditures	$9,587	$17,558	$26,259	$35,885	$43,883	$65,738	$38,256
Energy Expenditures as a Percent of Total Expenditures	6.1%	6.3%	5.6%	5.5%	5.3%	4.7%	5.2%

Source: Statistics Canada, Catalogue 62-555.

A sufficiently large reduction in the retail sales tax could completely offset the negative impact of a carbon tax on low income families. Also a portion of the carbon tax revenues could be used to finance a refundable energy tax credit for low income families which would completely offset the negative impact of the carbon tax. Finally, Ontario's electric and gas utilities could reduce their customers energy bills by installing energy-efficient equipment on their premises. If the price of energy rises by 20%, a customer's energy bill may not rise if their energy consumption declines by 20% or more.

ENDNOTES

1. Royal Society of Canada, Canadian Options for Greenhouse Gas Emission Reduction (COGGER): Final Report of the COGGER Panel to the Canadian Global Change Program and the Canadian Climate Program Board, (September 1993), p. 12.

2. According to the Retail Sales Act, "[m]achinery, equipment or processing material purchased for the use of a manufacturer" are exempt from the provincial sales tax. [Chapter R.31, page 26] Therefore eliminating the retail sales tax exemption does not entail that the sales tax would be applied to industrial consumers of energy.

3. Calculations are based on the following assumptions: i) long run constant price elasticities of demand for natural gas, oil and electricity of 0.5 and 1.0; ii) the full long run impact of a provincial sales tax on energy demand is achieved by 2005 and 50% of the long run impact is achieved by 2000; and iii) fossil-fired electricity is Ontario Hydro's marginal source of electricity 90% of the time.

4. Pollution Probe, The Costs Of The Car: A Preliminary Study of the Environmental and Social Costs Associated with Private Car Use in Ontario, (Toronto: Pollution Probe; 1991), p. 53.

5. Ibid., p. 54.

6. Richard Zucker and Glenn Jenkins, Blue Gold: Hydro-Electric Rents in Canada, (Ottawa: Minister of Supply and Services; 1984), p. 32.

7. Statistics Canada's implicit price index for gross domestic product was used to make the inflation adjustment. See Statistics Canada Catalogues 11-210 and 13-001.

8. Ontario Hydro Annual Report 1992, p. 24.

9. In 1992 Ontario Hydro's return of capital equalled $2.892 billion (debt guarantee fee $161 million, interest charges $2.419 billion, net income $312 million) and its total assets equalled $46.671 billion. Thus its nominal rate of return was 6.2%. However, in 1992 the GDP implicit price index rose by 1.6%. Therefore Hydro's real rate of return was 4.6%. Ontario Hydro Annual Report 1992, pp. 24, 33 and 34; Statistics Canada Catalogue 13-001.

10. John C. Evans, The Appropriate Cost Of Capital For Ontario Hydro, (Toronto: Coalition of Environmental Groups for a Sustainable Energy Future; 1992).

11. $46.671 billion x 0.044 (0.09 - 0.046) = $2.054 billion.

12. In 1992 the water subsidy was $1.291 billion and the rate of return on capital subsidy was $2.054 billion. Ontario Hydro's total revenues in 1992 were $7.768 billion. $3.345 billion/$7.768 billion = 0.43. Ontario Hydro Annual Report 1992, p. 33.

13. If wheeling is permitted on the Ontario Hydro system, the higher revenues could be collected by raising Ontario Hydro's transmission, as opposed to electricity commodity, rates.

14. Our estimates are based on the following assumptions: i) long run constant price elasticities of demand for electricity of 0.5 and 1.0; ii) the full long run impact of the tax is achieved by 2005 and 50% of the long run impact is achieved by 2000; and iii) fossil-fired electricity is Ontario Hydro's marginal source of electricity 90% of the time.

15. Department of Finance, Fiscal Policy and Economic Analysis Branch, Economic Studies and Policy Analysis Division, An Environmental CGE Model of Canada And The United States, Working Paper No. 92-04, p. 35.

16. DRI/McGraw-Hill, Canadian Competitiveness And the Control of Greenhouse Gas Emissions Through Imposition of a Carbon Tax, (June 1993), p. 1.

17. ibid., pp. 40, 41.

18. DRI/McGraw-Hill, Carbon Dioxide Emissions and Federal Energy Policy: A Discussion of the Economic Consequences of Alternative Taxes, (March 18, 1991), pp. 17, 23.

19. Darius W. Gaskins, Jr. and John P. Weyant, "Model Comparisons of the Costs of Reducing CO2 Emissions", American Economic Review, (May 1993), p. 319.

20. Our analysis assumes that the carbon tax has reduced Ontario's projected carbon dioxide emissions in 2005 by 20% relative to their 1988 level.

21. In 1992 Ontario Hydro's cost of fossil fuel was $620 million and its total revenues were $7.768 billion. Ontario Hydro, Annual Report 1992, pp. 33, 40.

22. An Environmental CGE Model of Canada And The United States, pp. 40, 41.

23. Letter from Louis Beausejour, Department of Finance to Jack Gibbons, March 31, 1994.

24. An Environmental CGE Model of Canada And The United States, pp. 40, 41.

25. Letter from Louis Beausejour, Department of Finance to Jack Gibbons, March 31, 1994.

26. Carbon Dioxide Emissions and Federal Policy, p. 19.

27. Letter from George Vasic, DRI Canada to Jack Gibbons dated July 4, 1991.

28. Carbon Dioxide Emissions and Federal Energy Policy, pp. 7, 18; An Environmental CGE Model Of Canada And The United States, pp. 3, 19.

29. Royal Society of Canada, Canadian Options for Greenhouse Gas Emission Reduction (COGGER): Final Report of the COGGER Panel to the Canadian Global Change Program and the Canadian Climate Board, (September 1993), pp. 18, 19.

30. According to the 1993 DRI/McGraw-Hill report, a $150 per tonne carbon tax would reduce Canada's real GDP by 1.6% in 2000 even if 100% of the carbon tax revenues are used to lower the levels of existing taxes. However, the report's GDP forecasts are based on the arbitrary assumption that the introduction of a carbon tax will not lead to changes in Canada's interest rates and exchange rate. As the report notes "if the dollar was allowed to float, it would depreciate in this simulation and the overall impacts to the economy would thus be less negative." Canadian Competitiveness And the Control of Greenhouse Gas Emissions Through Imposition of a Carbon Tax, pp. 12, 13, 15 and 16.

31. Darius W. Gaskins, Jr., and John P. Weyant, "Model Comparisons of the Costs of Reducing CO2 Emissions", American Economic Review, (May 1993), p. 320.

32. William D. Nordhaus, "Optimal Greenhouse-Gas Reductions and Tax Policy in the "DICE" Model", American Economic Review, (May 1993), pp. 315, 316.

5.0 Carbon Quotas

Ontario Hydro and Ontario's large industrial energy users are responsible for approximately 18% and 22% respectively of Ontario's fossil-fuel-related CO_2 emissions.[1] Thus, in total, they are responsible for approximately 40% of Ontario's CO_2 emissions.

The Government of Ontario could control the CO_2 emissions of Ontario Hydro and large industrial emitters by establishing carbon quotas for Ontario Hydro and each of the other large corporate emitters. Under such a system it would be illegal for the CO_2 emissions, of a corporation subject to a quota, to exceed the emissions permitted by the quota.

If the Government of Ontario's goal is to stabilize the CO_2 emissions of Ontario Hydro and the other large industrial emitters by 2000, the sum of their quota limits in 2000 must not exceed the sum of their actual emissions in 1990. Similarly, if the Government also wants to reduce their emissions by 20% by 2005, the sum of their quota limits in 2005 must not exceed 80% of their actual emissions in the base year.

Cost of Compliance: Quotas versus Taxes

Under a carbon tax regime a firm's cost of compliance equals its cost of reducing its CO_2 emissions by investing in energy efficiency or fuel switching and its carbon tax payments to the Government. However, under a system of carbon quotas a firm's cost of compliance is limited to its cost of reducing its CO_2 emissions by investing in energy efficiency or fuel switching. Thus the annual cost to Ontario Hydro and Ontario's other large industrial sources of CO_2 of achieving stabilization and a 20% reduction in their emissions will be $1.6 billion to $2.8 billion less under a system of carbon quotas than under a carbon tax regime.[2]

Impact on Competitiveness

The impact of a system of carbon quotas on the international competitiveness of Ontario's energy-intensive industries will depend on two key factors:

1. the CO_2 reduction policies of Ontario's major trading partners; and
2. how the responsibility for achieving the CO_2 reductions is allocated amongst Ontario Hydro and the large industrial emitters.

An Ontario system of carbon quotas which stabilizes the CO_2 emissions of large industrial energy users will not impair the competitiveness of Ontario industry if their interprovincial or international competitors are subject to equal or more onerous carbon dioxide reduction policies.

Furthermore, if the firms which are <u>not</u> subject to significant international competition are required to make relatively large CO_2 reductions and the firms which are subject to significant international competition are required to make relatively small CO_2 reductions, the impact of the CO_2 reductions on the international competitiveness of the Ontario economy will be minimized.

5.1 Option A: Carbon Quotas for Ontario Hydro and Other Electricity Generators

According to Natural Resources Canada's projections, Ontario's CO_2 emissions from electricity generation will fall from 26,102 kilotonnes in 1990 to 9,200 kilotonnes in 1994 and then rise to 13,375 and 25,457 kilotonnes in 2000 and 2005 respectively.

On the other hand, Ontario Hydro is predicting that Ontario's electricity-related CO_2 emissions, under a business as usual scenario, will be 24,800 in 2000.[3]

At present, the vast majority of Ontario's electricity-related CO_2 emissions are due to the operation of Ontario Hydro's coal-fired generating stations.

1990 Baseline for Carbon Quotas

If carbon quotas require Ontario Hydro and other electricity generators to stabilize their CO_2 emissions at their 1990 levels by 2000, there would be no reduction in Ontario's projected electricity-related CO_2 emissions in 2000.

However, if carbon quotas require Ontario Hydro and other electricity generators to reduce their CO_2 emissions by 20%, relative to their 1990 levels, by 2005, Ontario's electricity-related CO_2 emissions would fall by 4,575 kilotonnes relative to their projected level in 2005.

1994 Baseline for Carbon Quotas

Alternatively, if carbon quotas require Ontario Hydro and other electricity generators to stabilize their CO_2 emissions at their projected 1994 levels, Ontario's projected electricity-related CO_2 emissions in 2000 would fall by 4,175 to 15,600 kilotonnes relative to the Natural Resources Canada and Ontario Hydro projected levels respectively.

Furthermore, if carbon quotas also require Ontario Hydro and other electricity generators to stabilize their CO_2 emissions, at their projected 1994 levels, in 2005, Ontario's projected electricity-related CO_2 emissions in 2005 will fall by 16,257 kilotonnes relative to their projected level.

Impact of Carbon Quotas on Electricity Prices and Ontario Industry

The impact of a carbon quota on electricity prices would depend on the cost to Ontario

Hydro of reducing its CO_2 emissions by:

1) promoting energy conservation, energy efficiency and end-use fuel switching from electricity to renewable energy or natural gas (see Chapter 7); and

2) substituting renewable or natural gas-fired electricity generation for its coal-fired electricity generation (see Chapter 8).

Furthermore, the impact of a rise in Ontario Hydro's rates on the competitiveness of Ontario industry will depend on the following factors:

1) the degree to which the rise in Hydro's costs are passed on to its industrial customers (e.g., a 5% rise in Hydro's costs will not raise industrial rates if 100% of Hydro's increased costs are recovered by raising residential and commercial electricity rates);

2) the ability of industrial energy users to reduce their electricity consumption by investing in energy conservation, energy efficiency and fuel switching; and

3) the willingness of Ontario Hydro to facilitate the self-generation of electricity by Ontario industry.

The Appropriate Magnitude of Electricity-Related Carbon Quotas

There are a number of reasons why it could be in the public interest to require Ontario Hydro to substantially reduce its CO_2 emissions by 2000 and 2005:

1. Ontario Hydro's mission is "to make Ontario the most energy efficient and competitive economy in the world, and a primary example of environmentally sound and sustainable development."[4] If Ontario Hydro accomplishes its mission, Ontario's electricity-related CO_2 emissions will decline substantially. Thus requiring Ontario Hydro to substantially reduce its CO_2 emissions would be consistent with and supportive of Ontario Hydro's corporate mission.

2. Ontario Hydro's coal-fired generating stations are also significant point sources for the emission of sulphur dioxide, nitrogen oxides, particulates and air toxics which cause or are precursors to acid rain, urban smog, respiratory diseases and cancer. Thus carbon quotas which require Ontario Hydro to significantly reduce its generation of coal-fired electricity will provide multiple environmental and health benefits.

3. If requiring Ontario Hydro to substantially reduce its CO_2 emissions leads to a rise in electricity prices, the resulting negative consequences for the Ontario economy will be relatively small since:

i. Ontario Hydro, unlike many industrial sources of CO_2 emissions (e.g., Algoma Steel, Stelco) is currently not subject to international competition;

ii. electricity costs are a small proportion of the total costs of the vast majority of Ontario Hydro's industrial customers;[5] and

iii. the number of jobs created by Ontario's most electricity-intensive industries is relatively small.[6]

On the other hand, it might not be in the public interest to require Ontario Hydro to substantially reduce its CO_2 emissions for the following reasons:

1. Due to its large surplus of electrical generating capacity, Ontario Hydro's short run marginal financial cost of generating electricity is very low. That is, the short run marginal financial cost of electricity supply is significantly lower than the marginal financial cost of natural gas and oil. As a consequence, in the short run, it may be more cost-effective to reduce Ontario's CO_2 emissions by adopting measures to conserve natural gas and oil instead of coal-fired electricity.

2. The price of electricity rose substantially in 1991, 1992 and 1993. As a consequence, strict CO_2 quotas for Ontario Hydro may not be politically acceptable if they will lead to a further significant rise in electricity prices.

3. Ontario Hydro is a publicly-owned corporation that is in poor financial health. As a consequence, strict CO_2 quotas for Ontario Hydro may not be in the best interests of the Province of Ontario if they might jeopardize Ontario Hydro's ability to finance its $34 billion debt.

5.2 Option B: Carbon Quotas for Large Industrial Energy Users

i) Stabilization

Carbon quotas could be used to stabilize the CO_2 emissions of Ontario's large industrial energy users. Under this option the CO_2 emissions of large industrial users would be reduced by approximately 7,900 kilotonnes in 2000 and 12,700 kilotonnes in 2005 relative to their projected business as usual levels.[7]

The United States is committed to stabilizing its CO_2 emissions at its 1990 level by 2000. If the U.S. stabilization strategy requires its industrial energy users to stabilize their emissions, Ontario carbon quotas that stabilize the emissions of its large industrial energy users need not jeopardize the international competitiveness of Ontario's industries.

ii) A 20% Reduction

If Ontario's large industrial energy users are required to reduce their CO_2 emissions by 20% relative to their 1988 levels by 2005, their CO_2 emissions will be reduced by 20,755 kilotonnes relative to their projected level for 2005.[8]

Requiring Ontario's large industrial energy users to reduce their CO_2 emissions by 20% by 2005 need not jeopardize their international competitiveness if:

1) the U.S. requires its industrial energy users to reduce their CO_2 emissions by 20%; or

2) a 20% reduction in their CO_2 emissions can be achieved at no net economic cost.

If neither of the above conditions hold, the negative impact of requiring Ontario's large industrial energy users to reduce their CO_2 emissions by 20% will depend on the magnitude of this regulation on their costs of production.

5.3 Tradeable Carbon Quotas

i. Advantages

If the Government establishes a system of carbon quotas to control the emissions of Hydro and other large industrial emitters, the marginal cost of reducing CO_2 emissions will vary from corporation to corporation. For example, Inco's and Stelco's marginal costs of reducing CO_2 emissions might be \$100 and \$150 per tonne respectively. Under this scenario, the same aggregate reduction in emissions would be achieved if Inco saved an extra tonne and Stelco increased its emissions by one tonne. Furthermore, under this example, Ontario's total cost of achieving its reduction target would fall by \$50 (\$150 - \$100).

Thus, if the Government allows Hydro and the other large emitters to trade their CO_2 quotas, the cost of achieving the aggregate Ontario Hydro and industrial sector CO_2 reduction target will be reduced. In addition, if the Government lowers the aggregate CO_2 cap when it introduces emissions trading, the environment as well as the economy will gain from emissions trading.

ii. Disadvantages

On the other hand, if the Government of Ontario permits firms to trade their carbon quotas, the quotas will become property rights with a positive, and potentially very high, market value. It could be argued that giving valuable property rights to large corporations is not fair. In addition, some people may argue that it is especially inappropriate to give pollution property rights to Ontario corporations that are foreign-owned.

In this context it is important to note that if a company closes its plant because of a decline in the demand for its product (e.g., steel) or because it has decided to relocate its operations to another jurisdiction (e.g., Mexico), it could make a windfall profit from selling its carbon quota. In the extreme, a company might close its plant in order to sell its carbon quota for a profit.

Furthermore, under a system of tradeable carbon quotas, new or expanding companies would be required to purchase carbon quotas from established companies which received their quotas free of charge. Lastly, concerns have been raised regarding the administrative complexity of emission trading systems, and the resulting potential difficulties in ensuring compliance with system requirements.[9]

International Emissions Trading

An Ontario Hydro task force and TransAlta Utilities have recommended that emissions trading should be permitted between Canadian and Third World corporations.[10] According to Jim Leslie, Senior Vice President, TransAlta Utilities, U.S. companies have been able to purchase carbon sequestration from Central American and Malaysian companies for 50 cents to $1 per ton:

> "AES is an independent power producer in the U.S. that has set up a project under which they will sequester 10 million to 15 million tons of CO_2 in a forest project in Central America. The cost is in the range of 50 cents per ton of carbon.
>
> In the eastern U.S., New England Electric System has recently partnered with a Malaysian timber company in a forest management program that improves the use of the forest and reduces the damage to the forest resource at a cost of some $1 per ton of CO_2."

International emissions trading raises at least three important issues. First, how can it be determined whether the emission reduction in the foreign nation is incremental? That is, would the foreign nation have made the emission reduction (this year, next year or 10 years from now) in the absence of a 50 cents per tonne payment from a Canadian corporation? Needless to say, many foreign corporations would be happy to sell Ontario Hydro <u>phantom</u> emission reductions for 50 cents per tonne.

Second, will the emission reduction be permanent? For example, sequestering carbon in a tree plantation will only lead to a permanent reduction in CO_2 emissions if the tree plantation remains in existence in perpetuity. What corporation or government can provide such a guarantee?

Third, what should be the exchange rate between Canadian and foreign emission reductions? Should there be parity or should foreign reductions be discounted? If a 20% reduction in Ontario's CO_2 emissions is appropriate in the absence of international emissions trading, should Ontario's emission reduction target be increased if the cost of achieving the reduction is substantially reduced as a result of permitting international emissions trading?

A System for International Emissions Trading

International emissions trading will facilitate the achievement of global CO_2 reduction goals if and only if the global reduction in CO_2 emissions, under emissions trading, is at least as great as the global reduction in CO_2 emissions in the absence of emissions trading. In order to ensure the achievement of this objective the international emissions trading system must have the following two characteristics.

First, the emissions trading system must establish a binding aggregate CO_2 emissions cap, for the nations which are engaging in emissions trading, which is at least as low as their (explicit or implicit) aggregate CO_2 emissions cap in the absence of emissions trading. For example, emissions trading between Canada and Australia would not necessarily lead to a net reduction in global emissions if Australia is not subject to an emissions cap. For, absent an emissions cap, Australia would not have to reduce its own emissions in order to sell emissions quotas to Canada. In addition, if the emissions trading cap for Canada and Australia is greater than their explicit or implicit non-trading emissions cap, the emissions trading system will permit a rise in CO_2 emissions.

Second, the emissions trading system must establish an agency that will monitor the emissions of the member provinces or nations and will ensure their compliance with the emissions cap.

The establishment of a binding emissions cap and international monitoring agency would require extremely complex, and in many ways unprecedented, international legal and administrative arrangements. An effective international enforcement mechanism would be particularly difficult to achieve. The establishment of a successful international emissions trading system in the near future seems unlikely for these reasons.

The Potential Benefits of International Emissions Trading

In the absence of emissions trading, Ontario will have to reduce its projected CO_2 emissions by 56,059 kilotonnes in order to achieve a 20% reduction in its fossil-fuel-related emissions by 2005. If the average cost of these emission reductions is $10 per tonne, the total cost of achieving this goal will be $560 million. If CO_2 emission reductions in the Third World can be purchased for $1 per tonne, an emissions trading system would allow Ontario to buy 560,000 kilotonnes of CO_2 reduction for $560 million.

That is, given the above assumptions, an international emissions trading system would allow Ontario to buy the equivalent of a 350% reduction in Ontario's CO_2 emissions for the cost of actually achieving a 20% reduction of CO_2 emissions in Ontario.

On the other hand, if the average cost of reducing CO_2 emissions in Ontario is approximately the same as the average cost of reducing CO_2 emissions in the Third World, the potential benefits of international emissions trading would be much smaller.

The benefits of international emissions trading include opportunities for industrialized countries to share technology with lesser developed countries and an emphasis on finding the most cost-effective options available to meet emission targets. Critics of international emissions trading are concerned that developed nations will ignore cost-effective and environmentally beneficial domestic efficiency options, if they can get credit for building less CO_2-intensive energy supply systems in third world nations or buying carbon sinks in order to avoid domestic action on reducing energy consumption and CO_2 emissions.

ENDNOTES

1. According to the Canadian Energy Research Institute, large industrial energy users are responsible for approximately 75% of Canada's industrial energy consumption. Furthermore, according to CERI, it seems reasonable to assume that large industrial energy users are responsible for at least 20% of Canada's CO2 emissions. We have assumed that large industrial energy users are responsible for 75% of Ontario's industrial CO2 emissions and hence 22% of Ontario's fossil-fuel-related CO2 emissions. Merete Heggelund, Emissions Permit Trading: A Policy Tool to Reduce the Atmospheric Concentration of Greenhouse Gases, (Calgary: Canadian Energy Research Institute; 1991), p. 75.

2. Assuming that Ontario Hydro and large industrial energy users are responsible for 40% of Ontario's CO2 emissions, their total CO2 emissions in 1990 equalled 57,704 kilotonnes. Thus, if a carbon tax of $100 per tonne is required to stabilize their emissions at their 1990 level in 2000, their total carbon tax payments would be $1.6 billion (57,704,000 tonnes x .2727 x $100/tonne). [The carbon content of a tonne of CO2 is 27.27%.]
Assuming that Ontario Hydro and large industrial energy users are responsible for 40% of Ontario's CO2 emissions, their total CO2 emissions in 1988 equalled 64,282 kilotonnes. Thus, if a carbon tax of $200 per tonne is required to reduce their CO2 emissions by 20%, relative to their 1988 level, by 2005, their total carbon tax payments would be $2.8 billion (64,282,000 tonnes x .2727 x .8 x $200/tonne).

3. Don Power, Power Resources Planning, Grid System Strategies and Planning, Ontario Hydro, Ten Year Capacity and Energy Summary - Revision (April 13, 1994).

4. Ontario Hydro, Annual Report 1992, inside cover.

5. Ralph Torrie and Robin Skinner, Electricity And Industry In Ontario: Costs, Competitiveness & Sustainable Development, (Orleans, Ontario: Torrie Smith Associates; 1994).

6. ibid.

7. According to the Canadian Energy Research Institute, large industrial energy users are responsible for approximately 75% of Canada's industrial energy consumption and it appears reasonable to assume that they are responsible for at least 20% of Canada's CO2 emissions. We have assumed that Ontario's large industrial energy users are responsible for 75% of Ontario's industrial CO2 emissions. Merete Heggelund, Emissions Permit Trading: A Policy Tool to Reduce the Atmospheric Concentration of Greenhouse Gases, (Calgary: Canadian Energy Research Institute; 1991) p. 75.

8. According to Natural Resources Canada, Ontario's actual or projected industrial CO2 emissions in 1988 and 2005 are 40,456 and 60,038 kilotonnes respectively. Assuming 75% of industrial CO2 emissions are due to large industrial energy users, the actual or projected CO2 emissions of large industrial users in 1988 and 2005 are 30,342 and 45,029 kilotonnes respectively. Thus a 20% reduction in large industrial energy user emissions would reduce emissions by 20,755 kilotonnes [45,029 - (30,342 x 0.8)].

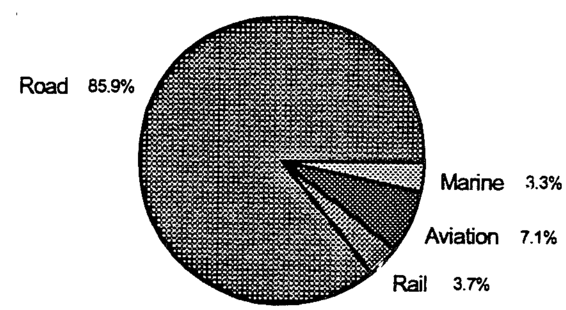
9. B.Heindenreich and M.Winfield "Sustainable Development, Public Policy and the Law" in J.Swaigen ed., Environment on Trial: A Guide to Ontario Environmental Law and Policy (Toronto: Canadian Institute for Environment Law and Policy and Emond-Montgomery Publishers, 1993), pp.xxxiii-xxxiv.

10. Ontario Hydro, A Strategy For Sustainable Energy Development and Use For Ontario Hydro, (October 18, 1993), pp. 75-77;

6.0 Transportation Sector

6.1 Overview

The transportation sector is responsible for about 30% of Ontario's CO_2 emissions. In 1990, Ontario's transportation sector produced 42,814 kilotonnes of CO_2 emissions. All types of road transportation account for almost 86% of the sector (see Figure 1). Cars and light trucks, in turn, contribute the majority of road transportation CO_2 emissions.



This chapter will primarily address Ontario's CO_2 emissions generated by the road portion of the transportation sector and the means to reduce these emissions. Air, marine and rail transportation CO_2 emissions will not be addressed in this discussion, due to their relatively small contribution to the road portion. The strategy to reduce CO_2 emissions in the transportation sector will be twofold:

1. promoting alternatives to cars and light trucks (e.g., public transit, bicycling, walking); and

2. reducing the CO_2 emissions of cars and light trucks (e.g., by increasing their energy efficiency and decreasing their emission intensity).

Part 1: Alternatives to Cars and Light Trucks

As Table 6.1 indicates, the transit-based alternatives to the automobile are capable of achieving substantial reductions in CO_2 emissions per kilometre travelled. In fact, as the last column of Table 6.2 demonstrates, CO_2 emissions can often be reduced by more than 5 tonnes per year for each car that is completely displaced by public transit. This table does assume however, that the transit modes are operating at near complete passenger capacity - a condition which may not always apply.

Table 6.1 : Avoided CO_2 by Preferring Transit to Automobile

Mode	Number of Passengers	Energy Intensity in kj per passenger per km	CO_2 Intensity in tonnes per passenger per 1000 km	Avoided CO_2 per automobile displaced in tonnes
Intercity rail	80	466	0.0326	5.9
Intercity bus	40	503	0.0352	5.8
Light rail	55	674	0.0472	5.6
City bus	45	728	0.0510	5.5
Rapid rail	60	793	0.0555	5.4
Car pool	4	1206	0.0820	4.9
Automobile	1	4827	0.3282	–

Source: Adapted from *Alternatives to the Automobile: Transport for Livable Cities* Table 2 pg.13 Worldwatch Institute 1990.

CO_2 Benefits of Reducing the Vehicle Stock

Therefore if improving public transit leads to a 10% reduction in Ontario's automobile stock in 2000, Ontario's CO_2 emissions would be reduced by 3200 kilotonnes. In 2005, a 10% vehicle stock reduction would lead to 3800 kt of avoided CO_2 emissions.

CO_2 Benefits of Reducing the Use of Cars

Without an actual reduction in the vehicle stock, CO_2 emissions could be reduced by a shift in travel modes. For example, Environment Canada has estimated the reductions in CO_2 emissions by simply encouraging commuters to use transit over motor vehicles for the commute to work. On an annual basis, a motor vehicle-based commuter will generate about 1.4 tonnes of CO_2 as compared to under 0.2 tonnes for the transit-based commuter. If the average 20 kilometre round trip to work each day were conducted by transit as opposed to motor vehicle, 85% of the CO_2 produced in getting people to and from work would be avoided. Table 6.2 provides an estimate of the amount of CO_2 reduced by encouraging more Ontarians to commute by transit:

Table 6.2: CO_2 Reductions through Commuting by Transit

Number of Persons Commuting	CO_2 Produced by Using Motor Vehicle (in kilotonnes)	CO_2 Produced by Using Transit (in kilotonnes)	Reduction in CO_2 Emissions Achieved (in kilotonnes)
100,000	140	20	120
300,000	420	60	360
500,000	700	100	600

Source: *Understanding Atmospheric Change* State of the Environment Report No.91-2, Environment Canada, March 1991.

While the precise number and proportion of all trips made by automobile in Ontario may be difficult to quantify, automobile travel is clearly the most popular form of personal transport in the province. Using Toronto's travel habits as the basis for comparison with other cities, Table 6.3 indicates that this city is somewhat more inclined toward non-car modes than some other jurisdictions in North America and Australia, however there still remains substantial capacity to shift the population from car to non-car modes.

Table 6.3 : Urban Densities and Commuting Choices, Selected Cities, 1980

City	Land Use Intensity (pop. + jobs/ha)	Private Car (%)	Public Transport (%)	Walking and Cycling (%)
Phoenix	13	93	3	3
Perth	15	84	12	4
Washington	21	81	14	5
Sydney	25	65	30	5
Toronto	59	63	31	6
Hamburg	66	44	41	15
Amsterdam	74	58	14	28
Stockholm	85	34	46	20
Munich	91	38	42	20
Vienna	111	40	45	15
Tokyo	171	16	59	25
Hong Kong	403	3	62	35

Source: Adapted from *Alternatives to the Automobile: Transport for Livable Cities* Table 5 pg.28 Worldwatch Institute 1990.

In a survey of an area more inclusive than Toronto, car use becomes even greater. An estimate of commuting modes is available from the Transportation Tomorrow Survey for the Greater Toronto Area (GTA) and the Region of Hamilton-Wentworth, which together embrace almost half of the province's population. In 1991 some 77 per cent of the approximately 10 million trips made each day by residents of this part of Ontario were made by automobile (up from 75 per cent in 1986). A further 14 per cent of trips were made by public transit (down from 17 per cent). Trips by other modes, chiefly walking and bicycling, accounted for the remaining 9-10 per cent of trips in each year. As the level of transit use is higher in the GTA and Hamilton-Wentworth than in most other parts of Ontario, the proportion of all trips made by automobile in Ontario in 1991 was greater than 77 per cent. It is apparent that the automobile is overwhelmingly the preferred mode of passenger transportation in Ontario and that its use is increasing.

6.2 Options for Increasing the Non-car Mode

Any approach to increasing the use of non-car modes of transportation must begin with a full understanding of the overwhelming attractiveness of the automobile. Table 6.4 sets out some of the advantages and disadvantages of the automobile.[1] The advantages are mostly for individuals; the disadvantages are mostly for society. The numerous individual advantages of the automobile have clearly helped to make it the most popular form of personal transport in Ontario. Indeed, the automobile's popularity in most parts of the province is increasing, at the expense of its alternatives.

A strategy aimed at increasing the use of non-car modes of transportation could embody programs capable of achieving one or more of the following goals:

1) reducing the advantages of the automobile for the individual;
2) enhancing alternatives to automobiles; and
3) changing individual habits and aspirations.

Table 6.5 lists some of the options to increase the use of non-car modes of transportation and their relation to the goals above.

Table 6.4 : Advantages and Disadvantages of the Automobile

Advantages for Individuals	Advantages for Society
Comfort: usually much more than transit or other alternatives	**Economy:** source of economic activity, stimulus
Convenience: a car is usually instantly available, 24 hours per day	**Democratic:** more citizens can manage their own transportation decisions than by transit
Hobby: use of leisure time both for driving and cleaning, restoring and collecting	**Plurality:** adds an extra transportation mode to urban systems; makes urban areas appear busy and vibrant
Low marginal cost: once the car is owned, the extra journey costs less than by transit or cab especially if parking is not charged additionally.	**Disadvantages for Society**
	Accidents: cost of medical care and property damage
Mobility: allows otherwise inaccessible places to be reached - for instance cottages and farms	**Air Pollution (global):** manufacture and use of cars and their fuel are a major source of CO_2 and Chlorofluorocarbons
Moving Goods, Including shopping: items can be readily transported and stored in the car temporarily	**Air Pollution (local):** cars are a major source of health-related pollutants - carbon monoxide, nitrous oxides, ozone, volatile organic compounds
Moving passengers: particularly young children, elderly relatives and others difficult to escort on transit	**Alienation:** both by their effects on individuals and urban form and reducing person-to-person contact
Ownership: allows pride of possession, reason to work	**Decay:** contributes to property degradation in inner cities along major arteries
Personal Safety: isolated from strangers on street or transit	**Land Use:** cars demand land both for driving and parking which displaces other uses, particularly agriculture
Privacy: allows user to play music or use cellular phone	**Energy Consuming:** major user of a limited resource: fossil fuels
Status: reflection of taste, values, maturity	**Health:** impacts through accidents and pollution are costly
Efficiency: often journeys are quicker than by transit	**Land Pollution:** from seepage of fluids and use of salt
Disadvantages for Individuals	**Policing:** automobiles cause a large part of policing costs
Accidents: risk is higher than for most other modes of transportation	**Congestion:** car congestion in urban areas enlarges other disadvantages: impedes and raises cost of road-based transit, impedes emergency vehicles and transport of goods
Exclusion: a car-oriented society can marginalize people who cannot drive for whatever reason - age, cost, disability	**Public Funds:** automobile infrastructure constitutes a demand for scarce public funds, particularly competing with public transit for funding
Cost: overall annual expenditure per car is high - more than $7,000 per year for a car less than four years old	**Noise and vibration:** a major concern in urban areas for its impact on people and buildings
Interference: with travel by pedestrians, bicyclists and transit users	**Resources:** the manufacture of cars involves massive consumption of materials whose supply is finite
Pollution: the air in cars is usually worse than ambient	**Visual Pollution:** facilities for cars are invariably unappealing
Sloth: contributes to physical unfitness	**Waste:** disposal of cars can be a major cost, environmentally and financially
Social Contact: inhibited by the isolation of an automobile	**Safety:** people not in cars may be generally less safe on account of cars - through accidents and the creation of hostile environments
Stress: of driving (especially in congested urban areas)	**Urban Sprawl:** cars encourage the growth of suburbs, which are expensive to service
Inefficiency: in instances of accidents, congestion and absence of parking, transit is actually faster	**Water Pollution:** from emissions and from paved driving spaces which cause rapid run-off into adjacent waterways
Worry: about damage or malfunction while on the road and theft or damage while parked	**Streets:** car traffic and parking arrangements create a hostile environment for pedestrians and other users of streets

Table 6.5: Options for Increasing the Use of Non-car Modes of Transportation

Reducing the Advantages of Automobiles	Enhancing Alternatives to the Automobile	Changing Individual Habits and Aspirations
through:	through improvements to:	through more or better:
1. Higher Fuel Taxes	6. Urban Public Transit	9. Automobile Rental Systems
2. Higher Parking Charges	7. Para-transit	10. Bicycle Transport
3. Road Metering and Charging	8. Inter-City Public Transportation	11. Pedestrian Travel
4. Higher Sales Taxes for Cars and Insurance		12. Movement of Goods
5. Limiting Road Supply		13. Education
		14. Car Pooling
		15. Urban Intensification

1. Higher Fuel Taxes

Higher fuel taxes would increase the cost of using the automobile for transportation. However the impact of this measure on automobile use would be critically influenced by two factors: i) the magnitude of the increased charges; and ii) the availability of acceptable alternatives.

In the absence of acceptable alternatives to the car, significant increases to fuel taxes would not be politically acceptable since they would impose a very real financial burden on many people and there would be the perception that they would provide minor environmental and other benefits. However, these objections might be overcome if 100% of the incremental revenues are used to enhance alternatives to the car. For example, the Government of Ontario could levy a higher gasoline tax only in those areas of the province where there is a viable public transit system and use the incremental revenues to subsidize public transit and improve facilities for bicycling. A fuel tax increase could also be used to encourage people to drive more fuel efficient vehicles as described in Part 2 of this chapter.

2. Higher Parking Charges

The Government of Ontario and/or municipal governments could establish a property tax surcharge for parking lots in areas where there is a viable public transit system. Once again 100% of the incremental revenues could be used to support alternatives to the car.

Furthermore, governments, public agencies and corporations could be encouraged to not provide free parking for their employees in areas where there is a viable public transit system. Moreover, the income tax system could be amended to make free public parking for employees a taxable benefit.

3. Road Metering and Charging

Road tolls could be used to increase the cost of using the automobile for transportation. Their impact on car use and ownership and their acceptability would be critically influenced by whether or not there are viable alternatives to the car. In areas where there are no viable alternatives, exceptions may be required. Road tolls may be manifested in two ways: (i) roads are designed with fee collecting structures through which motorists must pay to pass (ii) a road fee attached to an individual's vehicle registration which is kilometerage-based. The latter method was advocated by the Ontario Fair Tax Commission in its final report and is described briefly below:

> "Ontario should establish a new system of vehicle registration based on mileage, vehicle inspection results, and other vehicle characteristics related to road use, such as weight. Fees raised from this system should replace a portion of the revenue currently raised from transportation fuel taxes. Until this system is implemented, transportation fuel taxes should remain at their current levels."[2]

The Fair Tax Commission's intent in advocating a mileage-based registration fee was to more accurately capture the cost of road use that should be assigned to a vehicle. With regard to the new registration fee offsetting existing fuel taxes, this aspect of the measure might not be appropriate for reducing CO_2 emissions. If the proposed system also addresses some of the environmental problems caused by poorly maintained vehicles by designating a portion of the registration fee to vehicle inspection facilities, then that would also be a positive measure.

4. Higher Sales Taxes for Cars and Insurance

Higher rates of sales taxation for cars and/or car insurance would increase the cost of owning a car. However, since these taxes currently constitute a very small fraction of the total cost of owning a car, only a very significant increase of these tax rates would have a measurable impact on car ownership. Furthermore since these taxes do not vary with the number of kilometres driven, raising these taxes would not provide car owners with an incentive to drive less. However, a tax might be applied according to a vehicle's fuel consumption to help raise average vehicle efficiency as discussed in Part 2 of this chapter.

5. Limiting Road Supply

By not funding, promoting or providing any new automotive infrastructure (ie. roads, highways, bridges), the province of Ontario and all its cities and municipalities could provide a strong incentive for Ontarians to shift their mode of transport from automobiles to non-car modes. Limiting the road supply may cause vehicular congestion to result. Vehicle congestion has been recognized as one of the single most effective means of discouraging automobile use and encouraging the use of non-car modes. Newman and Kenworthy observed, by comparing cities of different densities, that as the amount of road space per person declined from 5.5 m/person (typical of a small to medium sized Ontario city) to 2.7 m/person (typical of Toronto), there was:[3]

> "a doubling in the number of passenger kms on public transport and the proportion of the total passenger transport task performed by public transport;
>
> a reduction in the number of passenger kms per person in cars by around 35% (ie. almost 4000 passenger kms per person less each year)."

If most municipalities in Ontario moved toward lower levels of road space per person, a great deal of support would be given to less fuel intensive means of transport.

With regard to the concomitant elevation in traffic congestion, Newman and Kenworthy concluded that:[4]

> "...that free flowing traffic does not lead to savings in fuel or lowering of emissions in a city overall. The means of achieving these savings appears to lie in more fundamental transport and land use planning related to travel distances and modes as well as in changes at the vehicle level."

By curtailing any further automobile infrastructure development, the Province of Ontario could help contribute to the stabilization of the vehicle stock. If 4000 kilometres per year could be reduced from the average vehicle's annual travel distance through road supply measures, then 4800 kilotonnes of carbon dioxide could be avoided in 2005.

6. Urban Public Transit

Public transit is normally thought of as comprising buses, streetcars and trains with publicized routes and schedules. Surveys of transit users have determined that public transit passengers want the following:

1) service that is frequent, reliable, speedy, and comprehensive as to time of day and places served;
2) a minimum of connections, with those that have to be made being convenient,

timely, and understandable;
3) comfortable, safe, and interesting accommodation within vehicles and in waiting areas;
4) readily accessible and understandable information about services;
5) accommodation of special needs, such as those of the elderly, the disabled, and carriers of very young children and baggage;
6) reasonable and conveniently payable fares.

The importance of individual features varies according to the circumstances of passengers and potential passengers. Enhancing any one of these features requires money, and part of the problem of public transit is underfunding. As noted above, increased funding for public transit could be obtained by earmarking the revenues from incremental fuel taxes, parking fees and/or road charges for public transit.

Alternatively, an ingenious way of securing substantial increases in funding for transit systems might be to require the purchase of a monthly transit pass as a condition of owning a vehicle within the operating area of a transit system. In Metropolitan Toronto this would amount to a vehicle licence fee of up to $800 a year (about 15 per cent of the present average cost of owning and operating a car), but the pass could have direct value to the vehicle user's household. The system would also be of indirect value to the continuing vehicle user. The fee itself would deter some vehicle users and thus reduce congestion. Also, the infusion of about $1 billion a year into the transit budget (an increase of well over 100 per cent) would result in increased ridership and further reductions in congestion. A strong feature of this kind of system is that the funds raised go directly to the transit system; they cannot be readily absorbed by government into general revenue.

Necessary institutional and other reforms

Perhaps the most necessary institutional reform, beyond those directly required to achieve the fiscal and other changes noted above, is the provision of a strong mandate for advocacy of transit interests. This could be achieved most readily in the major centres of Ontario by explicit assignment of such a mandate to transit operators. It would have to be supported by a complementary function within the Ontario government, possibly achievable by creation of a Ministry of Public Transportation.

Another necessary institutional reform would involve the achievement of a focus on the customers of transit systems and their needs, i.e., what is normally associated with the attitude of business to the provision of service as opposed to that of government. This may require the partial privatization of, or at least the explicit corporatization of transit systems.

7. Para-transit

Meeting all of the requirements of urban passengers and potential passengers by means of conventional public transit would be an extremely costly business, especially in suburban areas of sparse settlement. Para-transit, which may be defined as local public transit that provides a personalized service on demand (sometimes along specified routes), may be one way of complementing regular transit operations and thus meeting the passenger requirements. An example is a dial-a-bus service that reliably ferries customers from any point within a limited area to contact points within the regular transit system and to other locations. Another example is a jitney: a small bus that plies a particular route according to demand. Taxis may also be considered a form of para-transit.

Para-transit may have the added advantage of overcoming some of the concern of loss of safety arising from travel without an automobile as this mode is capable of emulating many of the safety features of a personal automobile.

Options to increase availability and use of para-transit

Para-transit may be owned and operated by the regular transit system or be under separate public or private ownership and operation, with or without subsidy. What may be required for them to flourish are appropriate licensing or franchising arrangements. Such arrangements should be designed to complement rather than compete with the regular public transit system. Where appropriate, competition can be avoided by withdrawing regular transit in favour of para-transit.

Fares for para-transit may or may not require regulation, according to circumstances. However, to maximize use of both para-transit and the regular transit system, fare integration should be arranged. An example of this in practice would be a dial-a-bus service for the Agincourt area of Metropolitan Toronto (in north east Scarborough) where a dial-a bus operator might charge two transit tickets for a ride to the subway for which one transfer would be given. Arrangements would have to be made for appropriate remittance of revenue to the transit system. In Rimouski, Quebec the public transit system recently replaced its conventional buses with a taxi system. Riders may be required to share a taxi but door-to-door service is provided within a guaranteed period of time and at only slightly higher fares than the previous fare.[5]

Most of the requirements for regular transit apply equally to para-transit. A particular requirement for para-transit, if it is to complement regular transit effectively, is availability of information about the service and how it relates to regular transit. Conventional taxis, which might be a central feature of a para-transit system, require a central dispatch service coordinated with or the same as that of the regular transit system.

Necessary institutional and other reforms

Several fundamental changes in attitude and institutional arrangements would have to occur before effective para-transit systems could be established in Ontario. One change would be the introduction of a process for licensing or franchising operators. Another change would involve clear recognition of taxis as public transportation. Subsidy of para-transit may be required to secure its availability.

8. Inter-city transportation

The requirements of passengers and potential passengers with respect to inter-city transportation are similar to those for local public transit, again with the importance of particular factors varying according to circumstances. A feature of inter-city transportation is that the most popular mode for journeys over a few hundred kilometres, air travel, is almost always more emission intensive (carbon dioxide and other emissions) per passenger-kilometre than travel by automobile. Thus, not all transportation modes outside the personal motor vehicle are to be encouraged.

Options to increase the use of inter-city public transportation are in general similar to those for local public transit. Raising marginal costs may be an especially effective way of reducing inter-city travel by automobile on account of the variation of marginal cost with distance.

The main alternatives to the automobile for inter-city travel are buses and trains. Whichever is promoted, there should be full integration with local transit systems. A common currency or token system for public transportation patrons throughout Ontario would help. Service improvements to make the charting of routes by map and by telephone easier would also assist users. Inaccessible suburban station locations encourage automobile use at each end of the inter-city journey; intra-city and inter-city public transportation systems should be much more connected. A similar consideration applies to airports and local public transit. Furthermore, many more links must be established between centres in Ontario to avoid gaps in public transportation. Such gaps occur when a passenger cannot get from one center to another without a transfer at some inconvenient and distant point or when a passenger simply cannot travel by public transportation from one center to another. An institutional change that would transform inter-city travel would be the establishment of the means and mechanisms for establishing high speed rail links (120 kmh or greater) between cities.

Automobile travel could still be employed to reduce emissions for inter-city travel by ensuring that vehicles are full when used. A method to improve automobile efficiency per person per kilometre is organized car pooling. Many colleges, universities and even some cities (Toronto, Ottawa, Montreal) have car pool networks for out-of-town travel. The systems facilitate car pooling by arranging communications between those supplying rides and those needing rides. Further promotion and support of these networks could reduce CO_2 emissions from inter-city travel.

9. Automobile Rental Systems

Because low marginal costs are a strong contributor to automobile use, any arrangement that helps to obviate automobile ownership may contribute to reducing carbon dioxide emissions. The ready availability of rental vehicles for the dozen times a year when automobile use may be truly essential can tilt the balance against ownership of a third, second or even the first vehicle in a household.

Accordingly, there may be reason to exempt short vehicle rentals from some of the increased costs of automobile use proposed above. A factor that could facilitate the practice of occasional vehicle rental as an alternative to ownership would be exemption of vehicles rented by residents from overnight permit parking regulations.

10. Bicycle Transport

The bicycle is an excellent all-purpose urban vehicle, even during most days of winter in southern Ontario. Bicycle use is an extremely low CO_2 emitting mode of transport; lower than even walking per person-kilometre.[6]

What bicyclists need above all is room on the road. A reasonable allocation of the travelled street allowance in urban areas might be to provide equal shares for (i) pedestrians, (ii) bicycles and other non-motorized vehicles, (iii) public transit, and (iv) all other vehicles including private automobiles and trucks. Portions of the bicycle path system in the City of Montreal are segregated from vehicular traffic by a concrete curb which prevents motorists from parking on, or temporarily using a bicycle lane. Most features designed to improve vehicle traffic flow, such as one-way street systems, are an inconvenience to bicycle users and a deterrent to bicycle use; they should thus be avoided if bicycle use is to be encouraged. Such measures could be adopted given the high degree of support for improvements to bicycle infrastructure, even by members of the automobile driving community.[7]

Bicyclists also need readily accessible and secure parking places and other institutionalized protections against theft, including an improved licencing scheme. Special attention should to be paid to the integration of bicycle use and public transit use, for example, secure bicycle shelters at bus, train and subway depots. Disallowing public transportation operators from excluding bicycles on board would help as would enhancing the ability to easily bring a bicycle on a bus or train trip.

A change in institutional regard for the bicycle is essential to a CO_2 reduction strategy. Rather than being confined to the margin with uncertain status as a vehicle, the bicycle could be promoted as a replacement to the private automobile for many citizens' basic mode of transportation in cities. If bicycle use could reduce the number of kilometres driven by the vehicle stock by 5%, then 1600 to 1900 kilotonnes of carbon dioxide could be reduced each year.

11. Pedestrian Travel

For distances of up to about two kilometres, walking for most people is an effective form of urban travel, and yet North Americans are inclined to use a vehicle, usually the private automobile, if a journey is more than even one-tenth of that distance. The main reason may be that walking in urban areas has become mostly an unpleasant and even an unsafe experience, largely because of the broad, high-speed, motor-vehicle oriented nature of public thoroughfares.

Walkers desire an adequate pathway, freedom from assault by malefactors and by vehicles (including their fumes and noise), and interesting sights. Presently these requirements are met in our urban areas only within malls and underground shopping concourses, which are free of vehicles.

The action that might lead to the greatest increase in walking would be a massive program for widening sidewalks: three metres of clear space should be the minimum width with five metres being desirable. Design features could prevent occupation of sidewalks by motorized vehicles (a scourge in many cities with wide sidewalks).

12. Movement of goods

High among the reasons given for automobile ownership and use is the need to move goods, chiefly new purchases. This need may be less strongly experienced if consumers demanded, and stores provided, more delivery of orders. Design of streets and public transport should have in mind the needs of the package carrying pedestrian and bicyclist. In the City of Montreal, hundreds of tricycles are used to deliver packages from local grocery stores to customers who phone in orders.

An aspect of the movement of goods that could inadvertently support public transit would be the favouring of freight movement by rail over road. This could allow more rail lines to remain in operating order and therefore keep open the option of reinstituting a strong passenger rail system.

13. Education

Almost all of the options outlined in this chapter will involve some amount of change in habits or lifestyle. Initially, some of the changes may be regarded as offering less convenience, mobility or freedom and are therefore not very attractive to adopt. For this reason it is crucial that both the environmental advantages as well as the individual and societal advantages be well communicated to the public. This section will provide some of the advantages to adopting CO_2 reducing options in the transportation sector that could be emphasized.

Driving Less:

- o reduces the stress and boredom of operating a motor vehicle for long periods of time;
- o reduces the risk of a transportation-related accident;
- o would reduce the need for large expanses of parking areas which are often considered hostile environments;
- o would reduce the noise levels in cities.

Transiting More:

- o provides more time for relaxing, reading, listening to music, or using a portable computer;
- o would allow cities to become more compact and neighbourhood-oriented by foregoing the need for broad car-based streets;

Cycling and Walking More:

- o provides an excellent source of exercise;
- o provides opportunities for social and environmental interaction;

Not Owning a Motor Vehicle:

- o almost always reduces the cost of transportation for individuals;
- o expands the range of modes by which one can travel (walk, bicycle, rent-a-car, boat, etc.);
- o avoids the time and cost of maintenance.

Education of youth allows the major possibility for change, particularly since this age group usually has not begun to make transportation decisions extensively. Promotion by government and business of society's interests, would also help. Finally, resistance to some options can be reduced by providing some implementation and adjustment period in many cases.

14. Car Pooling

As noted in Table 6.2, car pooling can be almost as effective as transit for reducing the emission intensity per passenger per kilometre. If 100,000 single passenger commuting motorists could be pooled into vehicles with 4 passengers then approximately 100 Kt of CO_2 could be avoided annually. High occupancy vehicle lanes and roadside parking lots can encourage car pooling, however this measure will still require a good deal of effort on the part of Ontarians to ensure that when they use their cars, they are used as efficiently as possible.

A method by which the Ontario Government could facilitate car pooling would be a voluntary questionnaire system at the time of vehicle or licence registration. The questionnaire could ask the vehicle owner if they mind car pooling with neighbours, and if so can the driver be contacted for ride-sharing if a 'match' is in the driver's area. Computer networks could be used to facilitate the broadcast of generic information regarding the location of potential drivers and their destinations (ie. Guelph to Hamilton and return, Monday to Friday, leave 7:00 am, return 4:30 pm).

15. Urban Intensification

Land use intensity is one of the single greatest factors affecting the mode of transportation chosen by an individual. Table 6.1 indicates that there is a strong relationship between urban land use intensity and mode choice. Policies encouraging intensification and discouraging sprawl would have an enormous effect on mode used over the longterm. The relationships between population density and transportation were estimated by Newman and Kenworthy, who observed that in cities with gross densities of 3000 to 4000 persons/km^2 or greater, urban transport was far less automobile based.[8] In addition, it was noted that in areas with densities below 3000 persons/km^2 bus service generally was quite poor and in areas below 2000 persons/km^2 there is a marked increase in the travel by car only.[9]

Urban intensification policies would tend to be complementary to other options designed to increase the non-car mode such as enhancing bicycle transport and para-transit systems. Also, since ridership increases as population density increases, policies that encourage urban intensification and discourage suburban sprawl can increase the financial viability of public transit. Such measures which replace automobile use with non-car modes of transportation will, in almost every instance lead to a reduction in fuel consumed and carbon dioxide emitted.

Part 2: Reducing Car and Light Truck CO_2 Emissions

6.3 Ontario's Vehicle Stock and Road Energy Demand

According to Natural Resources Canada, there are 3.89 million passenger vehicles and 1.38 million light trucks in the Province of Ontario.[10] These vehicles each emit, on average, 6 tonnes of CO_2 annually. The current average fuel efficiency of these vehicles is estimated to be 9.88 L/100 km for cars and 12.29 L/100 km for trucks.[11]

CO_2 emissions from motor vehicles are essentially a function of fuel consumed. The sum of fuel consumed by all vehicles is referred to as the Road Energy Demand. Road Energy Demand is the product of the stock of vehicles, the average fuel efficiency of the vehicle stock and the average distance travelled per vehicle.[12] The total CO_2 emissions from Road Energy Demand is obtained by multiplying by a standard conversion factor (for motor gasoline it is 2.36 tonnes per 1000 litres):[13]

$$\text{CO}_2\text{ Emissions from Road Energy Demand} = \text{Vehicle Stock} \times \text{Average Fuel Efficiency} \times \text{Average km Driven} \times \text{CO}_2\text{ Conversion Factor}$$

No Significant Change Scenario by 2005

Natural Resources Canada forecasts the total number of gasoline-based cars and light trucks in Ontario to reach 7.2 million by the year 2005. This represents an overall increase of 39.2% from the 1990 level. The distance travelled per car is projected to increase 3.7% by the year 2005, while the average distance travelled by truck will increase 11.7% by the year 2005. The only factor of Road Energy Demand not projected to increase the demand for motor fuels in future is vehicle efficiency. It is projected to improve moderately: about 3% per year between 1996 and 2000.[14] The average fuel efficiency of vehicles in Ontario in the year 2005 is projected to be 8.46 L/100 km for cars and 11.60 L/100 km for trucks. Given these predominantly fuel consumption-increasing trends, Road Energy Demand for cars and light trucks is projected to increase 26.4% over the period 1990-2005 in Ontario. This growth will translate into an increase in CO_2 emissions from the car and light truck segment of the transportation sector of 8,000 kt CO_2 over the period 1990 to 2005 (from 30,300 kt in 1990 to 38,300 kt in 2005).

There are a number of options which could be employed in the road portion of the transportation sector to contribute to a CO_2 emissions stabilization and reduction strategy. These options, and how they may contribute to reducing Road Energy Demand, are outlined in Table 6.6 and described below:

Table 6.6: Options for Reducing Road Energy Demand

Vehicle Stock	Average Fuel-Efficiency	Average km Driven	CO_2 Conversion Factor
is limited by:	*is improved by:*	*is reduced by:*	*is reduced by:*
1. Stabilizing the Vehicle Stock	2. Implementing CAFC Standards	7. Raising the Price of Gasoline	9. Cleaner Fuels / Drive Systems
	3. Technological Improvements	8. Driver Behavioural Changes	
	4. Consumption-based Tax or Rebate Schemes		
	5. Driver Behavioural Changes		
	6. Removing Fuel-Inefficient Vehicles		

6.4 Options for Reducing Vehicle Stock CO_2 Emissions

A table summarizing reductions achievable by implementing the following options appears at the end of this chapter.

1. Stabilizing the Vehicle Stock

If the number of new vehicles sold did not exceed the number retired each year then the vehicle stock would be held constant over time. Relative to the projected growth of the vehicle stock, a stock held constant at the 1990 level would represent a reduction in the vehicle stock in the years 2000 and 2005. Holding the vehicle stock constant over time would contribute significantly to the goal of CO_2 emission stabilization. For example, if the vehicle stock was limited to 5.17 million vehicles (the 1990 level), then the 2005 projected vehicle CO_2 emission level would be reduced by 10,700 kilotonnes. This would be achieved despite a projected increase in average kilometres driven but would be assisted by the projected increase in average fuel efficiency.

There would be no one simple, precise method or instrument to stabilize the vehicle stock. Rather it would require multiple direct and indirect methods of dissuading Ontarians from automobile use and towards alternatives. A combination of measures that reduce the advantages of the automobile for the individual and enhance the alternatives to automobile use, as outlined in the two parts of this chapter, may succeed in stabilizing the vehicle stock.

2. Implementing Corporate Average Fuel Consumption (CAFC) Standards

Corporate Average Fuel Consumption (CAFC) Standards or, as they are known in the United States Corporate Average Fuel Efficiency (CAFE) Standards, were first introduced in the U.S. in 1975 and required the fuel economy of new cars to increase from about 14 mpg in the early 1970s to 27.5 mpg by 1985.[15] Over the period 1975-1985 the average fuel efficiency of the entire vehicle stock rose to about 27 mpg largely as a result of manufacturers keeping up with or even ahead of the standards.[16] The program provided flexibility to manufacturers by applying the standard to a sales-weighted average for each manufacturer, instead of each individual vehicle. Thereby, some less fuel efficient vehicles were allowed to be sold by a manufacturer provided it sold enough fuel efficient vehicles so that the average efficiency of all cars sold by a manufacturer met or exceeded the CAFE Standard. Further flexibility was provided to the manufacturers by allowing them to earn credits for exceeding the standard in any year, and then allowing those credits to offset penalties in years when a manufacturer fell short of the standard.[17]

Because of the integrated nature of the automobile industry in North America, the Canadian segment is normally affected by standards instituted in the U.S. The American CAFE Standard has not changed (barring a minor modification in 1989) since 1986. Most projections of Road Energy Demand (including that of Natural Resources Canada and the model used in this analysis) assume a modest increase in new vehicle fuel efficiency on the basis that the U.S. will pass some sort of CAFE Standard improvement legislation in the near future (i.e. 3% per annum between 1996 and 2001).

Under the federally legislated, but as yet unproclaimed Motor Vehicle Fuel Consumption Standards Act, Canada would have the ability to establish its own, independent CAFC Standard.[18] Under the Energy Efficiency Act Ontario could have the authority to limit vehicles sold in the province to those which complied with a prescribed efficiency standard and even require that a label be affixed to designate so, provided that automobiles were designated a prescribed product under that Act.[19]

By setting its own fuel efficiency standards, Ontario could achieve significant CO_2 emission reductions. For example, Table 6.7 sets out groups of vehicles, currently available in Ontario, which meet or exceed an efficiency standard. All of these vehicles exemplify the most fuel efficient vehicles commonly available in Ontario today.[20] The vehicle groups are referred to, generically, as Group A, B and C and are differentiated respectively by their increasing standard of efficiency. If the types of vehicles in Group C, today's most fuel efficient vehicles, represented the average vehicle by 2005 through the use of efficiency standards, substantial reductions in CO_2 emissions could be achieved. The Group C vehicles have a combined highway/city fuel efficiency of 4.91 L/100 km for cars and 9.21 L/100 km for light trucks.[21] The reduction achieved from the projected 2005 level would be in the order of 13,400 kt.

Table 6.7 : Motor Vehicles and their Fuel Consumption Ratings

Cars	Trucks
Group A : Cars with a Highway Rating of 6.0 L/100 km or Better	**Trucks with a Highway Rating of 8.2 L/100 km or Better**
Cars Ave. Engine Size = 1.4 L Transmission Type = Manual five-speed with overdrive Ave. City Fuel Consumption Rating = 7.2 L/100 km Ave. Hwy Fuel Consumption Rating = 5.3 L/100 km Combined Fuel Consumption Rating = 6.4 L/100 km	Trucks Ave. Engine Size = 2.3 Transmission Type = Manual five-speed with overdrive Ave. City Fuel Consumption Rating = 10.6 L/100 km Ave. Hwy Fuel Consumption Rating = 7.9 L/100 km Combined Fuel Consumption Rating = 9.4 L/100 km
Group B : Cars with a Highway Rating of 5.5 L/100 km or Better	**Trucks with a Highway Rating of 8.0 L/100 km or Better**
Cars Ave. Engine Size = 1.3 L Transmission Type = Manual five-speed with overdrive Ave. City Fuel Consumption Rating = 6.3 L/100 km Ave. Hwy Fuel Consumption Rating = 4.9 L/100 km Combined Fuel Consumption Rating = 5.7 L/100 km	Trucks Ave. Engine Size = 2.45 Transmission Type = Manual five-speed with overdrive Ave. City Fuel Consumption Rating = 10.25 L/100 km Ave. Hwy Fuel Consumption Rating = 7.95 L/100 km Combined Fuel Consumption Rating = 9.2 L/100 km
Group C : Cars with a Highway Rating of 5.0 L/100 km or Better	**Trucks with a Highway Rating of 8.0 L/100 km or Better**
Cars Ave. Engine Size = 1.0 L Transmission Type = Manual five-speed with overdrive Ave. City Fuel Consumption Rating = 5.4 L/100 km Ave. Hwy Fuel Consumption Rating = 4.3 L/100 km Combined Fuel Consumption Rating = 4.9 L/100 km	Trucks Ave. Engine Size = 2.45 Transmission Type = Manual five-speed with overdrive Ave. City Fuel Consumption Rating = 10.25 L/100 km Ave. Hwy Fuel Consumption Rating = 7.95 L/100 km Combined Fuel Consumption Rating = 9.2 L/100 km
Cars from which Groups A, B and C were chosen: Dodge Colt, Eagle Summit, Ford Escort, Geo Metro, Honda Civic, Hyundai Excel, Hyundai Scoupe, Lincoln-Mercury Aspire, Mazda Precidia, Nissan Sentra, Pontiac Firefly, Saturn SC/SL/SW, Suzuki Swift Hatchback	*Trucks from which groups A, B and C were chosen:* Chevrolet S10 Pickup, Dodge Dakota, Ford Ranger, GMC S15 Sonoma, Nissan Truck, Toyota Truck

Source of Ratings: 1994 Fuel Consumption Guide, Transport Canada

To achieve a designated average fuel efficiency for the entire vehicle stock by 2005, its corresponding CAFC Standard would have to be implemented between five and ten years in advance of 2005.[22] This arises as a consequence of the age profile of the vehicle stock: that at any given point in time the median vehicle age is approximately five years old. If the standard continues to progress each year, then about five years are required for a given standard to become the average based on the rate of vehicle stock turnover.[23] If the standard does not progress each year, then approximately ten years are required for a given standard to become the average.

3. Technological Improvements

Improvements in the design of vehicles could achieve the joint goal of improving fuel efficiency and consequently reducing the CO_2 emissions produced by a vehicle per unit of distance travelled. This goal could be achieved through some or all of the following broad design measures:

(1) reduce engine displacement and in some cases cylinders per engine;
(2) reduce the acceleration capability and power-to-weight ratio of vehicles;
(3) improve the drive system and reduce rolling resistance;
(4) improve engine efficiency by reducing friction;
(5) reduce the curb weight of vehicles;
(6) improve vehicle form to reduce aerodynamic drag.

The choice of the types of technological improvements employed to meet emission targets would ultimately be made by the individual automotive manufacturers. Accordingly, little discussion of such methods will be provided here other than a summary of the efficiency gains that might be achieved by such methods. Table 6.8 summarizes the technological improvements and their ability to reduce energy intensiveness per unit travelled. These reduction estimates were provided by the American Council for an Energy-Efficient Economy which estimates that a standard mid-sized vehicle with a fuel economy close to the American new car fleet average could reduce its fuel consumption by 43% through a variety of technological improvements to its engine and drive system.[24] These improvements are considered near-term in terms of their ability to be implemented. The estimated costs of the fuel economy improvement measures in Table 6.8 are considered to be in the range of 3-5% of the average cost of a new car.

Some concern exists with respect to the concept of lighter vehicles. However, vehicles can be designed to be lighter in mass without sacrificing current space characteristics and without reducing vehicle safety. If lighter, more efficient vehicle designs are adopted in tandem with more rigorous speed limit enforcement and other safety measures (see option 5 ahead), then lightweight vehicle design need not pose a decrease in road safety. As well, if there is a concerted effort to make all vehicles lighter, then motorists will be protected against collisions with vehicles of varying masses.

Table 6.8: Summary of Near-term Automotive Technological Improvements

Energy Sink	Existing kJ/km	% of Sink	Existing Sink Reduced to	New kJ/km	% of Sink
Tire rolling resistance	1049	15	58%	606	15
Aerodynamic Drag	980	14	82%	803	19
Braking	932	13	85%	792	19
Accessories	389	5	70%	272	7
Vehicle Load Subtotal	3350	46	74%	2473	60
Effect of 2.5% increase in compression ratio on Vehicle Load Subtotal:			97.5%	2411	59
Engine friction, powered	3001	42	44%	1319	32
Engine friction, idling	854	12	44%	377	9
Engine Friction Subtotal	3855	54	44%	1696	41
Total	7184	100	57%	4108	100

Improvement in Fuel Economy (combined)	Existing	New
	8.73 L\100 km	4.98 L/100 km

Current vehicle size and space could be maintained while average new vehicle fuel efficiency could be improved to 5 L/100 km through technological improvements. If this were to occur, 5300 kilotonnes of carbon dioxide could be reduced in 2005.

4. Consumption-based Tax and Rebates Schemes

Taxation, through its effect on price has been shown to be an effective means of influencing consumer purchasing decisions. A well designed Consumption-based Tax and Rebate Scheme (popularly referred to as a 'feebate' scheme by amalgamation of the words 'fee' and 'rebate') can induce a meaningful reduction in fuel consumption and CO_2 emissions. An analysis of California's sales tax incentives for fuel efficient motor vehicles declared that: "Market incentives such as DRIVE+ can work together with standards to speed up the introduction of emissions reduction and fuel economy technology." The Acronym DRIVE+ refers to the State of California's program *Demand-based Reductions in Vehicle Emissions PLUS Improvements in Fuel Economy.*[25]

Motor vehicle sales in Ontario have been subject to a feebate scheme under various titles since 1989. The current scheme is referred to as the Tax for Fuel Conservation. From an environmental perspective, a feebate scheme should offer the consumer a clear advantage in the purchase of a fuel-efficient vehicle over the purchase of a fuel-inefficient vehicle. In brief, moderately and highly fuel-inefficient vehicles should have substantial taxes applied to them while highly fuel-efficient vehicles may be subject to a rebate.

In practice, the tax implemented in Ontario has provided a weak signal to the vast majority of car consumers because of its structure. The TFC provides an efficiency rebate to only 7 percent of cars, applies a virtual flat tax to the bulk of car sales, and assigns a somewhat substantial inefficiency tax to about 5 percent of cars. In its 1994 report, the Ontario Fair Tax Commission declared the existing structure to be substandard:[26]

> "Even where the tax does apply, its design undermines its potential value as an environmental measure. Current rates of tax as a percentage of the purchase price of the vehicle are probably too low to affect consumer choices to any significant degree. The rate structure contributes further to this ineffectiveness. Because about 90 per cent of passenger vehicles sold in Ontario currently fall in the fuel-efficiency range that attracts a $75 tax, for practical purposes the tax applies at a flat rate."

The existing tax and rebate schedule appears in Table 6.9.

Table 6.9: Existing Schedule of the Tax for Fuel Conservation

Tax for Fuel Conservation		
Highway Fuel Use Ratings (L/100 km highway)	Tax on New Passenger Vehicles	Tax on New Sport Utility Vehicles
under 6.0	(100)	0
6.0 to 7.9	75	0
8.0 to 8.9	75	75
9.0 to 9.4	250	200
9.5 to 12.0	1200	400
12.1 to 15.0	2400	800
15.1 to 18.0	4400	1600
over 18.0	7000	3200

Note: Items in parentheses denote a negative tax or rebate.

Source: *Tax for Fuel Conservation (Revised October 1992)*, Sales Tax Guide, Retail Sales Tax Branch, Ontario Ministry of Revenue.

Table 6.10 (below) represents a potential means of amending the Tax for Fuel Conservation to ensure that it does affect consumer choices to a significant degree. The arithmetic basis for the tax levels is a $200 per tonne carbon tax based on the fuel consumed over an assumed 200,000 kilometre vehicle lifespan[27]. The tax would be phased-in incrementally over a five year period to allow manufacturers to adjust to the shift in market demand. Its key to affecting demand would be its ability to establish a substantial price 'precipice' for consumers when considering the purchase of an automobile. For example, under the proposed scheme it would be financially attractive to opt for a slightly more fuel-efficient model to avoid a substantial tax; in turn it would be much less attractive to move into a less fuel-efficient option if you were in position to avoid the tax. A distinct difference between this schedule and the existing TFC schedule is the absence of rebates. However, by providing options to which the tax does not apply (ie. those vehicles below the year's designated level), the scheme at least provides the consumer with a discount the equivalent of the tax rate at that efficiency.

The amended schedule would commence in 1995 for the efficiency range 10.00 to over 18.00 L/100 km. The amended schedule incorporates the two highest brackets of the Tax for Fuel Conservation as they are adequate and should be maintained.

Table 6.10: Proposed Amended Schedule for the Tax for Fuel Conservation

Fuel Efficiency L/100 km (combined rating)	Year of Effect	Tax Applied to Cars	Year of Effect	Tax Applied to Light Trucks[1]
over 18.00	existing	7000.00	1995	7000.00
15.00-18.00	existing	4400.00	1995	4400.00
14.00-14.99	1995	3604.00	1995	3604.00
13.00-13.99	1995	3346.57	1995	3346.57
12.00-12.99	1995	3089.15	1996	3089.15
11.00-11.99	1995	2831.72	1997	2831.72
10.00-10.99	1995	2574.29	1998	2574.29
9.00-9.99	1996	2316.86	1999	2316.86
8.00-8.99	1997	2059.43	1995	0
7.00-7.99	1998	1802.00	1995	0
6.50-6.99	1999	836.64	1995	0
6.00-6.49	1999	772.29	1995	0
5.99 and below	1995	0	1995	0

(1) The Light Truck Category would include the vehicle categories: Pick-up Trucks, Vans and special purpose vehicles as designated in the *1994 Fuel Consumption Guide* from Transport Canada.

Revenues generated from a feebate scheme are usually used to rebate the purchases of fuel efficient vehicles. One concern with respect to rebates is the possibility that they might stimulate motor vehicle sales if their levels are overly generous. Many of today's most fuel efficient vehicles are currently the most inexpensive vehicles available as well; a generous rebate on these vehicles may be little more than a bonus to many consumer who would have chosen such a vehicle in any event. If the purchase of a rebated vehicle retires a very inefficient vehicle, that might be an improvement; if the purchase of a rebated vehicle merely adds to the vehicle stock, then little is gained. For this reason, converting fees into rebates might not be a suggested feature of a Consumption-based Tax and Rebate Scheme.

An aspect of concern when implementing such a scheme in a jurisdiction with an automotive industry is the scheme's effect upon the industry. The scheme would cause the demand for more fuel efficient vehicles in Ontario. However, as the average vehicle assembled in Ontario is somewhat more energy efficient than the average vehicle sold in Ontario, there is a small margin of efficiency to be obtained merely by Ontarians purchasing more of the vehicles built in their own province.[28] As well, since a large portion of Ontario's automobile production is exported to the United States, and therefore not subject to the tax, the tax would have no effect on the large exported portion of Ontario's automobile production.

A significant revamping of the Tax for Fuel Conservation could achieve meaningful reductions in CO_2 emissions. For example, by applying a tax to a progressively higher efficiency standard each year for five years, the TFC could be a very persuasive means of guiding the market toward a designated average fuel efficiency.[29] [30] If an average efficiency in the range of 6.0-7.0 L/100 km for cars and 9.0-10.0 L/100 km for trucks could be achieved by 2005 through a motor vehicle tax system, then a reduction on the order of 10,000 kilotonnes of CO_2 from projected 2005 levels would be achieved.

5. Driver Behavioural Changes to Improve Average Fuel Efficiency

Rigorous enforcement of the province's speed limits would conserve fuel and reduce emissions. For example, a vehicle achieving 10.5 L/100 km at 60 kmh may require as much as 14.5 L/100 km at 100 kmh under optimum conditions - an increase in fuel consumption of 38%.[31] The implementation of velocity surveillance and control measures such as photo radar will help curtail velocity violations.

Even a velocity reduction of 20 kmh, say from 110 kmh to 90 kmh, could reduce fuel consumption for most vehicles by 20%.[32] As a step toward reducing emissions generated by excessive vehicle velocity, the Province could enforce speed limits more vigourously. Setting the maximum speed limit in the province at between 80 and 90 kmh as opposed to the current 80 to 100 kmh range could provide significant reductions in fuel consumed and emissions produced.

6. Removing Fuel-Inefficient Vehicles from the Stock

Removing the most fuel-inefficient vehicles from the stock has the effect of raising the average fuel efficiency of the stock, even in instances where the vehicles are replaced (provided that the replacement vehicles are highly fuel efficient). Removal of some of the worst polluting vehicles, without their replacement, could stabilize and even substantially reduce the carbon dioxide emissions produced from motor vehicles. Some drawbacks to this option include: the cost of removing even 10% of the vehicle stock (500,000 vehicles) could be prohibitive if the Province is required to purchase the vehicles; and the need for a system of identifying the vehicles to be removed and negotiating the vehicles off the road. As well, many of the most fuel inefficient vehicles are also early model vehicles which suggests they may be retired sooner rather than later in the normal course of events. One measure that could encourage less efficient vehicles to be retired would be elevating the licence plate charge on older known high consuming vehicles. Other options may encourage the retirement of highly fuel consumptive vehicles as well, such as higher gasoline prices.

It should be noted that vehicle removal may be highly effective in reducing the emission levels of other greenhouse gases and contaminants such as nitrogen oxides (NOx), carbon monoxide (CO), and uncombusted hydrocarbons (HC). Levels of these emissions tend to be more dependent on the age of a vehicle and condition of pollution control equipment than is CO_2.[33] The Province of British Columbia has established a mandatory vehicle testing program to deal with these emissions, while Ontario has established a similar programme but only on a pilot project basis.[34]

7. Raising the Price of Gasoline

Taxes on petroleum products could have a substantial effect on the amount people drive, the number of passengers they drive with, the types of cars people drive and ultimately the amount of fuel spent and emissions produced by Ontario's vehicle stock. Taxes might be used in concert with other methods described here to reduce CO_2 emissions. Most analyses credit the steep increases in petroleum prices in the 1970s with fortifying to a large degree the energy conservation measures instituted by many petroleum-dependent jurisdictions during the period. Some argue that energy price increases are the principle driving force behind energy efficiency and that regulatory measures such as efficiency standards are not really required to achieve an increase in energy efficiency given a steep enough increase in energy prices.

According to a DRI/Marbek analysis higher fuel prices will lead to a reduced demand for travel as well as encouraging the purchase of fuel efficient vehicles[35] (see Table 6.11). As a result of the implementation of a $150 per tonne carbon tax commencing in 1994, new car efficiency would improve 6.8% by the year 2000 and kilometres travelled per new car would decline 10.9%. The tax is actually phased-in over three years: $40 per tonne in 1994; $75 per tonne in 1995; and $150 per tonne in 1996 and is considered capable of achieving stabilization at the 1990 level in the year 2000. The tax would have the effect of increasing the price of gasoline 9.6 cents per litre. Such a tax could reduce carbon dioxide emissions by 4000 to 6000 kilotonnes in the year 2000.

Table 6.11 : Effect of $150 Carbon Tax on Fuel Consumption

	1990	Base Case 2000	Carbon Tax 2000	Improvement over Base Case
New Car Efficiency in L\100 km	10.1	8.8	8.2	6.8 %
Fleet Car Efficiency in L\100 km	10.8	9.4	8.8	6.4 %
Travel per New Car in 1000s of km	20.3	22.0	19.6	10.9 %

Source: *Canadian Competitiveness and the Control of Greenhouse Gas Emissions Through Imposition of a Carbon Tax* DRI/McGraw-Hill, June 1993 pg.45

8. Driver Behavioural Changes to Reduce Kilometres Driven

Encouraging Ontarians to drive less, use public transit more (options described earlier in the chapter) and carry more passengers when they use their vehicles would reduce the number of kilometres driven each year. Driving a motor vehicle less may not reduce emissions by the entire amount of the avoided automobile kilometerage if the travel is replaced by some other form of hydrocarbon-based travel. Replacing automobile travel with flight in some instances may result in more CO_2 emissions; replacing automobile travel with bicycling or walking would decrease CO_2 emissions. Without making any assumptions about replacement travel, a reduction of 10% in the average kilometres driven by the vehicle stock in the year 2005 would reduce the projected 2005 carbon dioxide emissions by 3,800 kt.

9. Cleaner Fuels / Drive Systems

Propane and natural gas are projected to fulfil about 2.4% of Road Energy Demand by the year 2000 and possibly 3.4% by the year 2010.[36] Natural gas produces about 27% less carbon dioxide than motor gasoline on an energy unit basis; propane about 10% less. In order to make a significant contribution to CO_2 emissions reduction, natural gas would have to make a significant penetration into the automotive fuel market. For example, if natural gas alone penetrated the automotive fuel market at five times the projected rate of penetration for both propane and natural gas, it would supply 12% of Road Energy Demand in the year 2000. This would result in an emissions reduction of 1,000 kt of CO_2 in the year 2000. This estimate does not account for any negating effect caused by natural gas leakage from vehicles and distribution systems.[37]

A number of fuel and drive type innovations are emerging in the automotive field which could substantially alter the nature, quantity and point of emissions generated by automobiles. The fuel cell is a small, combustionless generator that converts a fuel stock to electricity on-demand. One type, the Ballard fuel cell, is approaching the point of being employed in applications such as motivating buses.[38] Most fuel cells currently available still emit CO_2 if they employ natural gas as the on-board source of hydrogen or will at least cause the emission of CO_2 through the production of gases required as fuel stock for the fuel cell.

With electric drive system vehicles no carbon dioxide is emitted at the point of transport. However, through the generation of electricity to power the vehicle there will be produced some quantity of CO_2. The quantity of CO_2 produced depends on how the electricity is generated. If the electricity were generated by hydraulic means, then no CO_2 would be produced. If the electricity used to power the car was generated by coal, then the CO_2 emissions per kilometre will in fact be worse than that of a conventional motor vehicle.[39]

The disadvantage of aggressively marketing these technologies from the point of view of CO_2 reduction is that these technologies are only recently being applied to replacing internal combustion engines for the vehicle stock and will therefore require a period of implementation and testing. Moreover, with electric vehicles, the net effect may be to increase CO_2 emissions. For these reasons it is not projected that they will play a substantial role in meeting the target of stabilization by the year 2000.

6.5 Methods to Achieve CO_2 Reductions and Their Effect

Without additional efforts to curtail CO_2 emissions from the light car and truck portion of the transportation sector, Ontario's cars and light trucks will generate 38,300 kt of carbon dioxide in the year 2005. This compares to 30,300 kt in 1990.

The achievable reduction values listed in Table 6.12 assume that each method is applied in isolation. The combined effect of two or more methods may not be simply the sum of each method's emissions reduction.

Meeting Targets : Stabilization by 2000

The following conclusions apply to the target of stabilization by the year 2000:

- A vehicle stock reduction of 30% from projected levels would meet the 2000 stabilization goal for the car and light truck portion of the transportation sector and would constitute an emissions reduction almost sufficient to achieve the stabilization target for the entire transportation sector. Similarly, a reduction in average distance driven of 30% would achieve the same targets.

- A very substantial increase in the projected use of natural gas by motor vehicles (6 times projected rate) would be required to meet the goal of stabilization.

o Virtually all the options in Table 6.12 would achieve the 2000 stabilization target for the car and light truck portion of the transportation sector. Only the fuel switching options in which natural gas penetrates less than 15% of the automotive market would not achieve the necessary reductions.

Table 6.12: Options and CO_2 Reductions Achieved

Option	Reduction from Projected Year 2000 CO_2 Level in kilotonnes	Reduction from Projected Year 2005 CO_2 Level in kilotonnes
Stabilizing the Vehicle Stock		
10% less than projected growth	3,200	3,800
20% less than projected growth	6,400	7,600
30% less than projected growth	9,600	11,500
1990 level in 2000/2005	4,800	10,700
Implementing CAFC Standards		
Group A Vehicle Efficiency	3,300	8,800
Group B Vehicle Efficiency	4,250	11,100
Group C Vehicle Efficiency	5,150	13,400
Consumption-based Tax Scheme		
Proposed Amended Schedule to the Tax for Fuel Conservation	~4,000	~10,000
Raising the Price of Gasoline:	4000-6000	na
Motor Vehicle Technological Improvements	na	5,300
Limiting Road Supply / Intensification	na	4,800
Distance Driven Reductions		
10% less than projected rate	3,200	3,800
20% less than projected rate	6,400	7,600
30% less than projected rate	9,600	11,500
Fuel Switching: Gasoline to Natural Gas		
3%	260	310
15%	1,290	1,550
30%	2,580	3,100

20% Reduction by 2005

o Implementing a CAFC Standard of 4.9 L/100 km (combined rating) by the year 2000 could achieve the 2005 20% emission reduction target for the car and light truck portion of the transportation sector.

ENDNOTES

1. Canadian Urban Institute, Cities without Cars: Report on Phase 1, May 1994.

2. Ontario Fair Tax Commission Fair Taxation in a Changing World, Report of the Ontario Fair Tax Commission, University of Toronto Press, 1993, Recommendation 67, p.571.

3. The relationship was based on a comparison of cities with approximately 5.5 metres of road space per person and cities with approximately 3.0 metres of road space per person and is detailed in Newman P. and Kenworth J. Cities and Automobile Dependence: An International Sourcebook, 1991 p.140-141.

4. Ibid.

5. Canadian Urban Institute, Cities without Cars: Report on Phase 1, May 1994.

6. Worldwatch Institute, State of the World 1990, pg 124.

7. Seventy-five percent (75%) of the members of the Canadian Automobile Association support measures which will provide more bicycle infrastructure as a means to reduce vehicle-related pollution as reported in the Canadian Automobile Association's News and Views newsletter, May/June 1994.

8. Newman P. and Kenworth J. Cities and Automobile Dependence: An International Sourcebook 1991, p.127-131.

9. Ibid.

10. Natural Resources Canada, input data on provincial basis for Appendix A-11: Reference Scenario Transportation Demand (Petajoules) in Canada's Energy Outlook 1992-2020 Working Paper, prepared by Energy and Fiscal Analysis Division, Economic and Financial Analysis Branch, Energy Sector, September 1993.

11. Ibid.

12. Ibid.

13. For fuels such as propane or natural gas, a different CO_2 conversion factor would apply.

14. Natural Resources Canada, Canada's Energy Outlook 1992-2020, September 1993, p. 22-23.

15. Ross M., Ledbetter M., Feng A., Options for Reducing Oil Use by Light Vehicles: An Analysis of Technologies and Policy, for the American Council for an Energy-Efficient Economy, December 1991, p.33.

16. Ibid.

17. Ibid.

18. Canadian Automobile Association, Energy Efficiency Strategy for Road Transportation, 1993 p.2.

19. Section 3. of Ontario's Energy Efficiency Act states that "No person shall offer for sale, sell or lease an appliance or product to which this Act applies unless, (a) the appliance or product meets the prescribed efficiency standard with respect to the appliance or product; and (b) a prescribed label that sets out the efficiency standard of the appliance or product is affixed to the appliance or product."

20. Vehicles which complied with the rating but which operate on diesel were not included. Diesel would not be considered a preferred fuel alternative to gasoline as it is 4% more carbon intensive than gasoline on an energy unit basis.

21. The combined highway/city fuel efficiency is not merely the arithmetic average of the highway and city ratings but a weighted average. Transport Canada and other rating bodies uses a formula of 45% of the highway rating plus 55% of the city rating to arrive at an overall fuel efficiency.

22. If a CAFC Standard continues to advance each year to a progressively higher level of efficiency, then within five years of the implementation of a specified standard, that standard will become the average efficiency of the vehicle stock. On the other hand, if a standard is specified and not advanced to a progressively higher level of efficiency each year after, then it will require approximately ten years for that standard to become the norm.

23. Canadian Automobile Association, 1993 Vehicle Durability Survey in the CAA's Car Buyer's Annual Autopinion '94, p.118. Also, Ministry of Transportation and Communications, Metropolitan Toronto Area Transportation Energy Study Background Report II : Energy Consumption and Intensity of Transportation Modes, December 1980 p.11C.

24. DeCicco J., Ross M. An Updated Assessment of the Near-Term Potential for Improving Fuel Economy, American Council for an Energy-Efficient Economy, November 1993, pg 40.

25. Levenson L., Gordon D., Drive +: Promoting Cleaner and More Fuel Efficient Motor Vehicles Through a Self-Financing System of State Sales Tax Incentives, Journal of Policy Analysis and Management 90, no.3 (1990) 405-15.

26. Ontario Fair Tax Commission Fair Taxation in a Changing World, Report of the Ontario Fair Tax Commission, University of Toronto Press, 1993 p.76.

27. Except for the two most efficient brackets of the tax scale (6.50-6.99 L/100 km and 6.00-6.49 L/100 km) where the tax drops to $100 per tonne to reflect the high rate of fuel efficiency of these vehicles.

28. Ibid p.76.

29. While the exact fuel conservation effect of feebate schemes is difficult to estimate precisely, DeCicco et al. have estimated the magnitude of taxes or feebates required to hold the 2010 light vehicle consumption to the 1990 level: "Achieving this goal through fuel pricing alone would involve fuel tax increases amounting to a 100% - 200% increase in consumer gasoline price. By contrast, this goal might be achieved with feebates averaging 5% - 10% of vehicle price (although fees and rebates on some vehicles would be larger). Vehicle pricing approaches such as feebates therefore have a greater potential for control of light vehicle fuel consumption." in Steering with Prices : Fuel and Vehicle Taxation as Market Incentives for Higher Fuel Economy, American Council for an Energy-Efficient Economy, December 1993, abstract and pg 15.

30. The tax should be indexed to the rate of inflation to ensure that its effectiveness does not diminish with time.

31. Ministry of Transportation and Communications, Metropolitan Toronto Area Transportation Energy Study Background Report II : Energy Consumption and Intensity of Transportation Modes, December 1980 p.14-16.

32. Transport Canada, 1994 Fuel Consumption Guide : ratings for new cars, pick-up trucks and vans published in conjunction with Natural Resources Canada and the Canadian Petroleum Products Institute, p.20.

33. J. Rusk, "Tailpipe Emissions to be tested" The Globe and Mail April 22, 1994. The Ontario Ministry of Environment and Energy has established a pilot project that will test motor vehicles for their emissions of NOx, VOC and CO. Drivers whose vehicles exceeded limits would be instructed to have their pollution control equipment repaired.

34. Ibid.

35. DRI Canada and Marbek Resource Consultants Canadian Competitiveness and the Control of Greenhouse Gas Emissions Through Imposition of a Carbon Tax June 1993, pg 45.

36. Natural Resources Canada, Canada's Energy Outlook 1992-2020, September 1993, p.24.

37. Methane, a component of natural gas, is a strong greenhouse agent. It is estimated by some that the escape of methane into the atmosphere may outweigh any benefits of switching to natural gas.

38. See "Carmakers say fuel cell may beat any superbattery" in the Toronto Star Saturday May 7, 1994, page L18.

39. An average vehicle produces 0.26 kg of CO2 per kilometre using gasoline. A vehicle using electricity derived from coal produces between 0.33 and 0.59 kg of CO2 per kilometre. Electric vehicles emit less CO2 per kilometre occur when the electricity is generated by nuclear or hydraulic sources. Source: Task Force on Greenhouse Effect Report 678SP Ontario Hydro, November 1989 pg 15.

7.0 Utility Conservation Programmes

Introduction

According to many energy studies, energy efficiency can cost-effectively deliver substantial reductions in energy consumption. For example, a Torrie Smith Associates study has concluded that energy efficiency could cost-effectively reduce Toronto's electricity consumption by 55%.[1] According to Amory Lovins of the Rocky Mountain Institute, energy efficiency could cost-effectively reduce electricity consumption in the U.S. by 75%.[2]

After reviewing many Canadian and American studies, a Royal Society of Canada report concluded:

> "By comparison, the studies reviewed by the COGGER Panel suggest an economic potential for emission reduction in Canada of about 20% relative to 1990 emissions, provided new measures of the kind suggested above are adopted. This amounts to a reduction of about 40% (237 megatonnes) by 2010 relative to the EMR [Energy, Mines and Resources now Natural Resources Canada] forecast. In our judgement, this level of emission reduction is worth doing even if no climate change due to GHG [greenhouse gas] emissions takes place."[3]

In other words, if these studies are correct, Ontario could simultaneously achieve a 20% reduction in its CO_2 emissions, an increase in its competitiveness and a rise in the material standard of living of its residents (i.e., a rise in the per capita real gross provincial product).

According to many studies, a vast array of cost-effective energy conservation options are not being implemented because energy consumers lack good information about the cost and reliability of their energy efficiency options and/or the capital necessary to invest in energy efficiency:

> "As a result of distortions between an individual's and society's determination of the costs and benefits of making energy efficiency improvements as well as industry's concerns about the reliability of new, untried technologies, a large pool of unexploited efficiency gains exists."[4]

There are a number of reasons why Ontario Hydro, Ontario's municipal electric utilities and Ontario's gas utilities (Centra Gas, Consumers' Gas and Union Gas) are ideal agencies to remove the information and capital barriers to energy efficiency. Due to economies of scale, Ontario's energy utilities can gather and analyze information about the costs and benefits of energy efficiency options at a much lower unit cost than their customers can. Since Ontario's energy utilities are credible, reputable and trusted corporations, they are ideal agencies to market energy efficiency services to their customers.

Ontario's energy utilities are typically willing to accept much longer payback periods than their customers.[5] For example, while industrial corporations often require payback periods of 1 year or less for energy conservation investments, Consumers' Gas and Ontario Hydro have been willing to accept payback periods of up to 70 and 100 years respectively for capital expenditures.[6] As a result, utilities can rent, at a market rental rate, high efficiency equipment which their customers would not be willing to buy. Alternatively, Ontario's utilities could enter into co-operative arrangements with third party financial institutions to facilitate low interest rate loans for energy efficient equipment. In short, utilities can exploit the "payback gap" to create financially sustaining conservation programmes.

Finally, it is important to note that there is a very high degree of political and corporate support for the aggressive promotion of energy efficiency by Ontario Hydro, Ontario's municipal utilities, Centra Gas, Consumers' Gas and Union Gas. For example, 80% of the municipal electric utilities, 92.6% of the corporate chief executive officers and 93.8% of the mayors who responded to the 1993 Climate Change Survey stated that they support the aggressive promotion of energy efficiency by Ontario Hydro, Ontario's municipal electric utilities, Centra Gas, Consumers' Gas and Union Gas.[7]

7.1 Utility Energy Conservation

Ontario's energy utilities have a poor track record of promoting energy conservation. It appears that this may be changing and according to utility promotional information they claim to be strongly committed to the promotion of energy conservation. In practice, Ontario's utilities have developed few cost-effective and successful energy efficiency and conservation programmes.

The wide divergence between the utilities' environmental objectives and day-to-day actions reflects the fact that conserving energy is often contrary to their self-interest.

Gas Utilities

According to the Ontario Energy Board (O.E.B.), Ontario's gas utilities (Centra Gas, Consumers' Gas and Union Gas) should promote energy conservation. However, as a result of the O.E.B.'s rate-making principles, there are at least two reasons why the promotion of energy conservation by Ontario's gas utilities could be contrary to the financial self-interest of their shareholders.

First between rate cases, a gas utility's earnings are linked to its natural gas throughput volumes. That is, the higher are its throughput volumes the higher are its earnings and conversely, the lower the volumes, the lower the earnings. This is true whether or not the throughput volumes are above or below their forecast levels. As a consequence, a gas utility is financially penalized if it promotes energy conservation, since conservation by definition reduces throughput volumes, and therefore earnings, from what they otherwise would have been.

The second reason is that in the long run, a gas utility's earnings are linked to the magnitude of its invested capital. As a result conservation measures that reduce a gas utility's rate of growth of invested capital will also reduce its earnings growth per share.[8]

Ontario Hydro

Ontario Hydro sells electricity to over 300 municipal electric utilities. In addition, Ontario Hydro sells power directly to rural customers.

Ontario Hydro, unlike Ontario's gas utilities, is a publicly-owned corporation and hence its corporate self-interest is not maximizing earnings per share. On the contrary, Ontario Hydro's corporate mission is to promote energy efficiency, international competitiveness and sustainable development:

> "Our continuing purpose at Ontario Hydro is to make Ontario the most energy efficient and competitive economy in the world, and a primary example of environmentally sound and sustainable development."[9]

Nevertheless, the aggressive promotion of energy conservation can be contrary to the corporate objectives of Ontario Hydro and the short run financial self-interest of some of its customers for one or more of the following reasons.

First, electricity conservation measures will reduce the amount of electricity Ontario Hydro is required to produce. Hence conservation programmes will reduce the employment opportunities for Ontario Hydro employees whose skills are related to the generation and transmission of electricity.

Second, since Ontario Hydro has surplus capacity, its marginal revenue from an incremental sale exceeds its marginal costs. For example, Ontario Hydro's net marginal revenue (marginal revenue - marginal cost) from an incremental electricity sale to a municipal utility is approximately 1.5 to 2.7 cents per kwh.[10] As a result, electricity conservation programmes will require Ontario Hydro to raise its rates or reduce its costs in order to balance its revenue requirement. Neither option is necessarily consistent with the corporate objectives of Ontario Hydro. To be specific, raising rates would be politically unpopular and would further undermine public respect for Hydro employees. Reducing costs would require further layoffs and/or wage cuts.

Third, since the aggressive promotion of electricity conservation during a period of surplus generation capacity will typically lead to higher electricity rates; electricity conservation programmes may not be in the short run financial self-interest of Hydro's customers who are not direct beneficiaries of the conservation programmes. [N.B. Electricity conservation programmes can be in the short and long run financial self-interest of the programme participants even if their electricity rates rise. For example, if a customer's electricity consumption drops by 10%, the customer's electricity bill will fall even if electricity rates rise by 5%.]

In short, Ontario Hydro's promotion of energy efficiency may be constrained by its need to balance competing corporate and public policy objectives.

Municipal Electric Utilities

Ontario's publicly-owned municipal utilities distribute the electricity that they purchase from Ontario Hydro.

Everything else being equal, there are economies of scale in the distribution of electricity. As a result, a municipal utilities marginal net revenues from an incremental sale can be as high as 9 cents per kwh. As a result, electricity conservation programmes will typically require municipal utilities to raise their rates or reduce their costs in order to balance their revenue requirements. As noted above with respect to Ontario Hydro, neither option is necessarily consistent with the corporate objectives of a publicly-owned utility or the short-run financial self-interest of all of its customers.

7.2 Aligning Utility Objectives With The Aggressive Pursuit of Conservation

In order to ensure that Ontario's utilities will aggressively pursue all cost-effective conservation options, the Government of Ontario must implement structural and regulatory reforms which will more closely align the utilities' corporate objectives with the promotion of energy conservation.

Gas Utilities

There are at least three important actions that the Ontario Energy Board (OEB) can take to ensure that Centra Gas, Consumers' Gas and Union Gas will aggressively and cost-effectively promote energy conservation:

1) The OEB can reduce a gas utility's allowed rate of profit if it fails to aggressively and cost-effectively promote conservation.

2) The OEB can adopt an accounting mechanism which decouples the link between a utility's short-run profits and its gas sales. A decoupling mechanism will ensure that a gas utility is not financially penalized when it saves energy.

3) The OEB can establish shared savings incentives for the gas utilities. Under a shared savings incentive a utility would be eligible for a financial bonus that is directly linked to the net savings (total incremental savings minus total incremental costs) that flow from its conservation programmes. For example, if a conservation programme provides a total net financial saving of $1 million, 10% of the savings ($100,000) could be passed on to the utility's shareholders and 90% ($900,000) to the utility's customers.

The California Public Utilities Commission has adopted the above noted regulatory reforms. As a consequence the Pacific Gas and Electric (PG&E) Company has become the world's largest private investor in energy efficiency programmes.[11]

> "Approximately 600,000 of PG&E's customers participated in some 50 CEE [Customer Energy Efficiency] programs in 1992, saving enough electricity to supply almost 91,000 homes for a year, and enough gas to heat about 86,000 homes annually. As a result, air emissions were reduced by more than 3.8 million tons of carbon dioxide.
>
> Shareholders will earn in excess of $50 million pretax under an agreement with regulators that allows the company to earn based on energy savings achieved."[12]

The above reforms could be combined with a directive from the Ontario Energy Board or the Minister of Environment and Energy that Ontario's gas utilities should, on a best efforts basis, implement programmes and policies to: i) <u>stabilize</u> their gas sales by 2000; and ii) <u>reduce</u> their gas sales by 20%, relative to their 1988 levels, by 2005.[1] The former initiative would reduce Ontario's projected CO_2 emissions in 2000 by approximately 10,000 kilotonnes. The latter initiative would reduce Ontario's projected CO_2 emissions by approximately 21,000 kilotonnes in 2005.[13]

Ontario Hydro

The Government of Ontario could ensure that Ontario Hydro will aggressively promote energy conservation by establishing a CO_2 control order which prohibits Ontario's electricity-related CO_2 emissions from exceeding their projected level for 1994 (i.e., approximately 9200 kilotonnes[14]). Under this scenario, the aggressive promotion of electricity conservation by Ontario Hydro would be in the best interests of Ontario Hydro's customers since electricity conservation would be a very cost-effective option to achieve compliance with such a control order. Assuming the above noted CO_2 control order, Ontario's projected CO_2 emissions would be reduced by approximately: i) 4,000 to 16,000 kilotonnes in 2000; and ii) 16,000 kilotonnes in 2005.[15]

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1. Exclusive of incremental gas sales to the electricity generation and transportation sectors.

Municipal Electric Utilities

Conservation could be aligned with the municipal utilities' financial self-interest if Ontario Hydro were to pay them for each kwh of electricity that they save. That is, a Hydro conservation payment per kwh saved could ensure that a municipal utility's rates would fall when it saves electricity.[16]

Furthermore, if Ontario Hydro provides adequate conservation payments, the municipal utilities will be under pressure from their ratepayers to aggressively and cost-effectively save electricity. For, everything else being equal, municipal utilities which achieve relatively large reductions in sales, at relatively low cost, will experience the greatest rate declines.

ENDNOTES

1. Royal Society of Canada, Canadian Options for Greenhouse Gas Emission Reduction: Final Report Of The Cogger Panel, (1993), pages 29-40.

2. Ibid.

3. Royal Society of Canada, Canadian Options for Greenhouse Gas Emission Reduction (COGGER): Final Report of the COGGER Panel to the Canadian Global Change Program and the Canadian Climate Program Board, (September 1993), p. 12.

4. Canadian Competitiveness And the Control of Greenhouse Gas Emissions, p. 20.

5. Florentin Krause and Joseph Eto, Least-Cost Utility Planning Handbook For Public Utility Commissioners, Vol. 2, (Washington, D.C.: National Association of Regulatory Utility Commissioners; 1988), p. II-5; Ontario Environmental Assessment Board, Ontario Hydro Demand/Supply Plan Hearing, Ontario Hydro interrogatory response # 4.7.46.

6. Ontario Energy Board, E.B.R.O. 487, Technical Conference Transcript, Vol. 2, (March 17, 1994), p. 567; Ontario Hydro Annual Report 1992, p. 30.

7. Jack Gibbons, Greg Jenish, Patricia Merriman and Richard Robinson, 1993 Climate Change Survey Report, (Toronto: Canadian Institute For Environmental Law and Policy; 1993), page 30, question 10; page 36, question 10; and page 41, question 10.

8. Paul H. Jeynes, Profitability and Economic Choice, (Ames, Iowa: Iowa University Press; 1968), Chapter 2.

9. Ontario Hydro, Annual Report 1992, inside cover.

10. Ontario Hydro, H.R. 22, Submission To The Ontario Energy Board: Vol. 2 Submissions On 1995 Electricity Rates, (March 1994), p. 68; Ontario Hydro, Power System Planning Division, Provision of Energy Prediction Incremental System Values of Power and Energy, (July 1993).

11. Pacific Gas and Electric Company, 1992 Summary Annual Report, p. 4; Natural Resources Defense Council and Pacific Gas and Electric Company, "Energy Efficiency in the National Energy Strategy: NRDC and PG&E Find Common Ground", The Electricity Journal, (October, 1990), p. 41.

12. Pacific Gas and Electric Company, 1992 Summary Annual Report, p. 7.

13. Ontario's 1988 non-transportation and non-electricity generation natural gas-related CO_2 emissions equalled 41,840 kilotonnes. Economic and Financial Analysis Branch, Energy Sector, Natural Resources Canada, "Reference Case CO_2 (September 1993)".

14. Economic and Financial Analysis Branch, Energy Sector, Natural Resources Canada, "Reference Case CO_2 (September 1993)".

15. According to the Natural Resource Canada and Ontario Hydro, business as usual forecasts, Ontario's electricity-related CO_2 emissions in 2000 will be 13,375 and 24,800 kilotonnes respectively.

16. To be precise, a municipal utility's rate would fall if the conservation payment per kilowatt-hour (kwh) saved exceeds the utility's net cost of saving a kwh and the utility's foregone profit as a result of a reduction in its sales by one kwh.

8.0 Non-Utility Generation

In Ontario, non-utility generation (NUG) refers to the generation of electricity by an entity other than Ontario Hydro. Ontario's non-utility generators include private sector corporations and municipal utilities. Most of Ontario's non-utility generation consists of small hydro projects, natural gas turbines and natural gas co-generation facilities. (Co-generation is the simultaneous generation of process heat and electricity in a single facility).

CO_2 Reduction Benefits of NUG

Ontario Hydro's CO_2 emissions could be reduced by substituting renewable and/or natural gas-fired generation for Ontario Hydro's fossil fired electricity. For example, the CO_2 emissions per kilowatt-hour of gas-fired co-generated electricity are 66 to 70% less than those of Ontario Hydro's coal-fired generating stations.[1]

If all of Ontario Hydro's fossil-fired generation were displaced by gas-fired co-generated electricity, Ontario Hydro's CO_2 emissions would fall by approximately 8,830 to 16,370 kilotonnes in the year 2000 and by approximately 16,800 kilotonnes in the year 2005.

Types of Non-Utility Generation

Non-utility generation can be used to substitute for Ontario Hydro generation on the supply-side or the demand-side.

On the supply-side, Ontario Hydro can meet its customers' electricity demands by purchasing electricity from NUGs instead of operating its coal-fired stations at full capacity or building new capacity (supply-side NUG).

On the demand-side, private sector corporations or municipal utilities can generate some of their own electricity requirements and thereby reduce their electricity purchases from Ontario Hydro (load displacement NUG).

Quantity of Non-Utility Generation Available

According to a report, The Potential for Non-Utility Generation in the Province of Ontario: Synthesis Report, prepared by Steven G. Diener & Associates, Quaesitum and Luymes Associates Inc. for the Independent Power Producers Society of Ontario:

1) 7,000 megawatts (MW) of non-utility industrial co-generation could be produced at a cost of 4 cents per kwh (1991$);

2) 9,160 MW of non-utility generation could be produced at a cost of 5 cents per kwh (1991$); and
3) 14,342 MW of non-utility generation could be produced at a cost of 8 cents per kwh (1991$)[2]

By comparison, Ontario Hydro has 12,289 Megawatts of fossil (primarily coal) generation capacity.

The report's cost estimates are based on two key assumptions: the 1991 price of natural gas, $3.00 per million BTU delivered in Ontario, was escalated at 2% per year net of inflation; and costs were discounted using a 5% real or inflation-adjusted discount rate.[3]

According to the report, if gas prices are escalated at 4% per year net of inflation or if a 10% real discount rate is used, over 2000 MW of co-generated electricity could be produced at 4 cents per kwh and 8,000 MW of co-generated electricity could be produced at 5 cents per kwh.[4]

Load Displacement vs Supply Side NUG

A load displacement NUG provides greater savings to the Ontario Hydro system since it displaces Ontario Hydro generation, transmission and distribution capacity whereas a supply-side NUG just displaces generation. For example, a supply-side NUG would reduce Ontario Hydro's costs by 3.41 cents per kwh (1993$) in 2000.[5] On the other hand, a load displacement NUG, with the same average capacity factor, would reduce Ontario Hydro's costs by 4.24 cents per kwh in 2000 (1993$).[6]

Thus, at the margin, in 2000, if a kwh of load displacement non-utility generation costing 4 cents per kwh could displace a kwh of Ontario Hydro supply, Ontario's electricity costs would be reduced by 0.24 cents (4.24 cents - 4.0 cents). Furthermore, since the CO_2 emissions per kwh of natural gas-fired co-generated electricity are 66 to 70% less than those of Ontario Hydro's coal-fired electricity generation stations, Ontario's CO_2 emissions would also fall.[7] That is, given the above assumptions, at the margin, substituting load displacement non-utility generation for Ontario's fossil generation in 2000 would simultaneously reduce Ontario's energy costs and its CO_2 emissions.

Needless to say, if the cost of non-utility generation exceeds 4.24 cents per kwh, there will be a net economic cost for reducing Ontario's CO_2 emissions by substituting non-utility generation for Ontario Hydro generation. For example, if Ontario's CO_2 emissions are reduced by substituting supply-side non-utility generation, costing 5 cents per kwh, for Ontario Hydro's fossil-fired generation, the cost would be approximately $33 (1993$) per tonne of CO_2.[8]

On the other hand, if Ontario's CO_2 emissions are reduced by substituting a load-displacement non-utility generation, costing 5 cents per kwh, for Ontario Hydro's fossil fired generation, the cost would be approximately $15 (1993$) per tonne of CO_2.[9]

It is important to note that the above conclusions are based on the assumption that fossil generation will be Ontario Hydro's marginal generation source 90% of the time in 2000. If a significant portion of Ontario Hydro's fossil generation is replaced by non-utility generation, Hydro's fossil generation will be on the margin less than 90% of the time and hence the cost of reducing Ontario's CO_2 emissions by substituting non-utility generation for Ontario Hydro generation will rise.

NUG Proposals Available

Proposals have been put forward by several communities in Ontario (Toronto, Windsor, Kingston, Hearst, White River) to build cogeneration NUG facilities to meet their local energy requirements. Evaluating these projects from the perspective of community sustainability adds to the environmental attractiveness of community NUGs. For example, the proposed cogeneration facility in Toronto would be an integrated district heating, district cooling and electrical generation facility. According to the project's proponents, CO_2 emissions in the City of Toronto would be reduced by 857 kilotonnes and Toronto Hydro customers and City taxpayers would save $2.8 billion over twenty years. There would be enough savings generated by the project to purchase and shutdown the Lakeview coal-fired generating station.[10]

Other NUG projects, particularly those in the pulp and paper and saw mill communities in Ontario could result in dramatic increases in energy efficiency as well as cost savings for the communities and industries involved. In fact, cogeneration represents an important opportunity to enhance Canada's competitiveness in the pulp and paper sector.[11]

Conclusions

The Government of Ontario could achieve significant CO_2 emission reductions by requiring Ontario Hydro to gradually phase-out its coal-fired generation capacity by purchasing NUG.

Alternatively, if Ontario Hydro's CO_2 emissions are controlled by CO_2 quotas, increased use of NUG would be one of the options available to Ontario Hydro to ensure that its CO_2 emissions do not exceed the maximum emission limits permitted by its CO_2 quotas.

ENDNOTES

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3. ibid., p. 76.

4. ibid., pp. 82, 83.

5. Assuming the NUG has a 85% annual capacity factor. See Ontario Hydro, Power System Planning Division, Power Resource Integration Department, Provision Of Energy Prediction Incremental System Values Of Power And Energy, (July, 1993).

6. ibid.

7. Ontario Hydro, Task Force On Greenhouse Effect: Report 678SP, (November 1989), p. 8.

8. According to Ontario Hydro, its CO2 emissions per kwh of fossil generation in 2000 will be 0.0009163 tonne/kwh. If Ontario Hydro's fossil generation is on the margin 90% of the time, a NUG will reduce Ontario Hydro's CO2 emissions per kwh on average by 0.0008246 tonne [(0.0009163)(.9)]. Assuming the NUG's CO2 emissions per kwh are 66% lower than those of Ontario Hydro fossil generation, the NUG's CO2 emissions per kwh will be 0.0003115 tonne [(0.0009163)(.34)]. Thus the net reduction in CO2 emissions is 0.0005131 per kwh [0.0008246 - 0.0003115]. The net cost of the CO2 emission reduction equals the difference between the cost of the supply-side NUG and Ontario Hydro's generation, namely, 1.68 cents per kwh [5.09 cents - 3.41 cents {5 cents (1991$) = 5.09 cents (1993$)}]. A CO2 emission reduction of 0.0005131 tonnes for 1.68 cents is equivalent to a CO2 emission reduction of 1 tonne for $32.74. Ontario Hydro, "Summary Notes of Ontario Hydro Greenhouse Gas Emission Workshop, December 15-16, 1993" (February 2, 1994), Attachment 2; Ontario Hydro, Task Force On Greenhouse Effect, p. 8; Statistics Canada Catalogue 13-001.

9. Assuming Ontario Hydro's average incremental CO2 emissions per kwh in 2000 are 0.0008246 tonnes and that the average transmission and distribution losses are 6%, Hydro's average incremental CO2 emissions per kwh consumed at the point of end-use will be 0.0008741 tonnes [(0.0008246)(1.06)]. If the CO2 emissions per kwh of a load displacement gas-fired co-generator are 0.0003115 tonnes per kwh, the net reduction in CO2 emissions per kwh will be 0.0005626 tonnes [0.0008741 - 0.0003115]. According to our assumptions the net cost of this CO2 reduction is 0.85 cents [5.09 cents - 4.24 cents {5 cents (1991$) = 5.09 cents (1993$)}]. A 0.0005626 tonne reduction for 0.85 cents is equivalent to a 1 tonne reduction for $15.11. See previous footnote for more details and Ontario Hydro, Provision Of Energy Prediction Incremental System Values Of Power And Energy, (July, 1993), p. 5.

10. O'Donohue, Tony, Notes for a Presentation to the Fourth Annual Canadian Independent Power Conference, November 16, 1992.

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9.0 Buildings

9.1 Introduction

Energy use for buildings is typically categorized as a component of residential sector or commercial sector energy analyses. In this report, measures affecting the buildings themselves, as opposed to all energy consumption in the sectors, has been segregated in order to focus on targeted building policy options that apply across the two sectors.

The building sector refers to residential and commercial buildings in Ontario. The sector can be divided into the following categories, according to energy demand:

- space heating, which is governed by the building envelope and the heating,ventilation and air conditioning (HVAC) system within the building;
- water heating; and
- lighting.

Space heating is by far the largest contributor of CO_2 emissions in both the residential and commercial building sectors, accounting for nearly two-thirds of an average home's CO_2 emissions and half of a commercial building's. Water heating accounts for about 15 percent of a home's CO_2 emissions but is negligible as a percentage of the commercial sector. Lighting, on the other hand comprises 17% of commercial CO_2 emissions and accounts for 2% of residential emissions.

Improving the energy efficiency of buildings was ranked first, even over vehicle efficiency, as the most cost efficient and potentially most effective technical method (three times more efficient than vehicles emissions) of reducing CO_2 in the United States (Table 9.1). Given the similarities between the United States and Canada this should hold true for Canada, especially given our colder and generally longer winters.

Table 9.1: CO_2 Mitigating Options, Costs, and Potential Emission Reductions

Mitigating Option	Cost $/tonne of CO_2	Potential Emission Reduction in tonnes CO_2 equivalent per year
Building energy efficiency	<0	900 million
Vehicle efficiency	<0	300 million
Industrial energy management	<0 to 9	500 million
Transportation System Management	<0 to 9	50 million
Power Plant heat rate improvements	<0 to 9	50 million

Source: National Academy of Sciences, 1991

The residential and commercial sectors accounted for 32% of Ontario's energy-related CO_2 emissions in 1990.[1] The residential sector accounts for 20% and the commercial sector accounts for 12%. These emissions include the CO_2 attributed to electricity generation resulting from the use of appliances, as well as CO_2 emissions from oil and gas used for space and water heating.

The focus of this section is on the policy options that improve the overall building efficiency, reducing CO_2 emissions related especially to space heating, one of the most important factors. Section 10.0, following, addresses efficiency levels for appliances and equipment.

There are two basic policy approaches for improving the building envelope efficiency of residential and commercial buildings. The traditional approach for new buildings is the building code, which legislates minimum standards with respect to insulation values and other features. The primary drawback of the building code as a policy tool is that it only applies to the new building sector and major renovations which involve the increase in a house's floor area.

In order to address the existing building stock, the kinds of policies which have been used successfully in the past have been government incentive programs such as the federal Canadian Home Insulation Program (CHIP).

Other policies and programs include indirect methods of encouraging efficiency such as supporting research and development, providing consumer information, training for trades and the R2000 program.

9.2 Residential Sector

Ontario homes use a relatively large amount of energy. For instance, single-family electric Swedish homes use on average approximately 110 kWh/m^2, while Ontario homes use about 130 kWh/m^2.[2] One of the major reasons for this difference is that the Swedish government has historically had higher insulation standards in new housing than in Ontario [3]. This standards gap is closing, if not already closed, but the impact of Sweden's higher standards on recent building stock will provide efficiency benefits for many years into the future. Differences in style of living, individual behaviour and general environmental awareness also contribute to Sweden's lower residential energy intensity.

Using conservative estimates of no energy price rise in next 30 years, the federal Department of Energy, Mines and Resources indicated that improving the thermal efficiency of homes by: air sealing; retrofitting high performance windows; and installation of high efficiency furnaces and heat recovery ventilators to ensure adequate ventilation would save 62 PJ or 20% of Ontario's residential energy consumed for heat for less than 4 cents/kWh.[4]

Policy options for improving energy efficiency and reducing CO_2 emissions in the residential building sector fall under four basic categories:

- strengthening the energy efficiency provisions of the Ontario Building Code;
- demonstrating the successful use of high efficiency products;
- switching to less carbon intensive sources and more efficient uses of energy;
- increasing the use of renewable energy;
- information and education on the importance of energy efficiency for environmental and economic reasons, including the need for individual and collective action to improve energy efficiency in Ontario.

Building Codes

There is no technical reason why new homes in Ontario cannot use 60 percent less energy than an average new home built to existing provincial building code requirements, using commercially available products. The Advanced House in Brampton has demonstrated this achievement, using passive solar design, high performance windows, lighting and appliances, and a sophisticated Heating, Ventilation, and Air Conditioning (HVAC) mechanical system.

The Advanced House is a demonstration project designed to showcase leading edge technologies. It includes prototype technologies which are not yet commercial and therefore the house is prohibitively costly. It is an important program for demonstrating and testing new technologies. Using life-cycle assessments of these improvements increases the benefits of the added investment. Moreover, the peak electricity reduction in the Advanced House results in considerable avoided costs of new supply for utilities.

The Ontario building code is one of the most aggressive building codes in the world, as it should be given our standard of living, climate and relatively high energy consumption. Building codes are one of the most effective policy tools governments have for improving the efficiency of the housing stock.

Unlike equipment standards, there are no real competitive reasons why Ontario's building code cannot be dramatically improved using commercially available technologies and building techniques. One of unique policy options for improving energy efficiency without limiting the choices of consumers is:

o to establish an energy budget for homes based on planned occupancy, which would limit the total amount of energy consumed by the home but not limit choices with respect to how the energy is used.

There are a number of specific improvements to the building code which could be adopted to improve energy efficiency and lower emissions of CO_2. For example, the

National Energy Code for Houses now under development includes an externalities parameter based on the life cycle cost of the fuel and materials being used in a house. Ontario could take advantage of the externalities research currently taking place in the province and develop an appropriate externalities value to be used in the building code.

Home builders have been identified as perhaps the most significant opponents to building standards development. This opposition is understandable given that their primary interest is to build homes quickly and cost-effectively so that they can be offered to consumers at the most reasonable prices. Unfortunately, their particular concerns are focused on the initial capital cost of a home and not on the long term operating costs.

For example, homebuilders have opposed full height basement insulation, a recognized energy efficiency benefit, due to the added costs of finishing basements and the argument that foundation leaks would not be detected. If a home were viewed from the perspective of the potential cost savings to the occupant over the life of the home, than many more stringent energy efficiency measures would be considered economic and therefore could be adopted in the building code.

Information, communications, training and mechanisms to overcome first cost financial barriers would be required for home builders and home buyers. There is a view among those who support more aggressive building codes that the building industry's resistance to change carries a disproportionate weight compared to the benefits that consumers and the environment would realize. Others are concerned that increasing first costs means some people will never be able to purchase a home.

One of the most difficult aspects of ensuring energy efficient buildings is proper installation. This is one area where the building code can be improved, measured in terms of a buildings air-tightness. Specifically:

- the R2000 standards for air-tightness testing could be included in the building code.

Building Retrofit Market

The building code has the most impact on new construction. There are two policy options that would help to make existing building stock more efficient. The first is a Home Energy Rating Service which evaluates the efficiency of a house and provides the house with a rating or label so that a prospective buyer will know in advance the cost of heating and electricity. The system can be based on a set of technical efficiency standards or on a technical tool that assesses the home's energy efficiency in comparison to other homes.

A special retrofit fund could be linked to the home energy rating system whereby a revenue neutral fee would be collected at the time of sale and held in a fund. The new home owners could then use money from the fund to undertake energy efficiency upgrades of the house to improve its overall energy rating.

The second opportunity for building retrofits is to apply the building code requirements to building renovation projects that meet certain tests.

Building Demonstration Program

In addition to building codes, education and demonstration programs can encourage higher standards than building codes and can act as market-driving initiatives.

The R2000 program was a successful initiative, however the standards have advanced to the point that the program no longer provides the forward-looking vision that it once did. R2000 could be providing a vision for the technologies that will be widely available 5 to 10 years in the future. One policy option is to upgrade R2000 to meet targets that are well beyond existing standards and codes. Ontario Hydro (perhaps through PowerSmart) together with the federal and provincial governments could be working to revitalize R2000, for example, incorporating near Advanced House standards and renaming the program R2020 (20/20 Vision). The following examples could be included:

- energy efficient motors and fans;
- minimum 75% efficiency for heat recovery ventilators;
- use of at least one renewable energy technology;
- minimum 90% efficiency for all fossil fuelled heating systems;
- increase efficiency of all hot water heaters;
- increasing water conservation in toilets and showerheads;
- increasing insulation levels

Fuel Switching

Fuel switching, from inefficient and CO_2 intensive energy sources to more efficient sources, represents a significant opportunity for CO_2 reduction in Ontario. Electric water and space heating could be switched to renewable energy sources or to high efficiency natural gas (90% or greater for fossil fuel space heating), where available.

Switching from electric resistance heating to high efficiency natural gas reduces CO_2 in three ways. Electric space heating and to a lesser degree water heating, make up the majority of Ontario's coal intensive winter peak demand. The energy conversion by gas appliances in the home is far more efficient than burning coal to generate electricity. High efficiency gas furnaces are now 90 percent efficient, whereas the efficiency of coal burning, including transmission losses, is only 30 percent. Finally, natural gas produces nearly half the CO_2 of coal, per unit of energy produced.

Specific policy measures to encourage fuel switching in the residential sector may include:

- o restrictions on the use of electric heating (in areas where natural gas is available);
- o a fee for electrical heating hook-ups;
- o gas utility financing incentives for high efficiency gas equipment;
- o adoption of environmental externalities adders in fuel pricing

It is important to note that there are electric technologies that exist which are highly energy efficient. For example, the integrated mechanical system used in Advanced House is electric and ground source heat pumps are driven electrically.

Renewable Energy

There are significant opportunities for reducing CO_2 through a number of simple solar heating measures. For example, the Canadian solar water industry estimates that about 75% of Ontario's homes could be retrofitted with solar hot water heating and save between 26 PJ to 50 PJ of energy. With the proper incentives 80% of indoor and outdoor heated pools could switch to solar hot water heating which combined with the use of more efficient motors in the circulating pump could save a total of 5.4 PJ.[5]

The Passive Solar Potential in Canada study concluded that significant opportunities exist for the commercialization of new technologies such as, high performance windows and integrated mechanical systems like those found in the Advanced House. The market potential for Ontario's residential sector is 61 PJ by 2010.[6]

U.S. studies suggest that solar photovoltaics (PVs) could be commercialized for conventional applications (as opposed to remote) as early as 1995-2000. CIS (copper indium diselinide) modules costing $50/m^2 seem to be feasible in the short term and would mean that in New York the total cost for intermittent peaking power provided by CIS PVs could be less than 6 cents/kWh by 1995.[7] Estimates of the potential for PV supply in Ontario vary widely, but start at about 1 PJ over the next 10-15 years. The potential could be significantly higher especially in the residential and commercial sectors where PVs could be sited on roof tops and only be used during peak hours and therefore would not require energy storage.

Specific measures to encourage the adoption of solar technologies in residences include:

- o instituting an increasing performance standard for new buildings;
- o incentive programs for switching to renewable energy;
- o utility solar hot water leasing programs;
- o solar heating requirements for swimming pools;
- o including environmental externalities in fuel prices;

Wood stoves are another form of renewable energy gaining in popularity in Ontario, and they comprise an important component of residential heating in rural and northern Ontario. The Environmental Protection Agency in the U.S. has approved new low emission wood stoves which burn at a higher efficiency than standard stoves and have lower pollution emissions. Wood burning has several very positive aspects. It can be considered to be CO_2 neutral if the wood is harvested sustainably and it is generally a very cost-effective option for certain regions in the province. On the down-side is the high level of other emissions associated with wood-burning.

- o encourage sustainable forestry in the province, including education for small woodlot owners and individual harvesters and regulations for commercial fire wood operations;
- o regulate efficiency levels for wood burning stoves;
- o provide information to consumers on efficient operating procedures for wood stove use;

In total, a potential of 110-120 PJ of renewable energy exists in the residential sector in the current building stock.[8]

9.2.1 CO_2 Reduction Potential

If the policy options described above are selected to be implemented and achieve a reasonable degree of success, then significant CO_2 reduction may take place over the next decade.

Estimates vary on the total CO_2 reduction potential available. According to one report advocating aggressive measures to reduce CO_2, residential CO_2 emissions could be reduced by 34% (10,000 kt) from 1988 to 2005 if the following measures are implemented:

- o all new houses are built to the standard of the Advanced Home in Brampton by 2005, i.e. use one-third the energy of today's new houses;

- o space heating needs in 75% of existing homes are cut by 25% by 2005 by retrofitting with a combination of air sealing, insulation, improved windows, and high efficiency furnaces;

- o electric appliances are replaced by models 20-40% more efficient;

- o 30% of existing homes get their domestic hot water from solar hot water heaters.

9.2.2 Cost Implications

There are two important points to make with respect to the cost implications of reducing CO_2. First, the cost-effective potential, measured in direct dollar savings, is much greater than is typically estimated.[9] Second, estimates for cost savings generally do not consider life-cycle analysis nor the full environmental and social benefits of improving energy efficiency. Each of these points tend to under-represent actual cost savings of improved energy efficiency.

With respect to the first point, the savings reported are considered to be much smaller when technologies are analyzed after only a few years performance.[10] Furthermore, estimates of today's best electricity saving technologies can save twice as much as five years ago, but at only a third of the real cost[11].

The second point describes one of the major difficulties in determining the cost effectiveness of CO_2 reduction measures, namely, assigning all of the benefits and costs of the measures accurately. In particular, it is generally much easier to identify and quantify the costs than the benefits. For example, the classic environmental cost-benefit analysis dilemma is assigning a value to an individual's willingness to pay for: clean air, clean water, a more comfortable home, no acid rain, greater security knowing the supply of fossil fuels is being extended, better quality of life, and much more. Typically, these "externalities" are not considered when evaluating the cost-effectiveness of energy efficiency measures. Extensive debate is needed if individual consumers and decision-makers wish to move toward a more energy efficient economy.

All sectors of the province may wish to engage in a comprehensive debate to help alleviate some of the uncertainties associated with these questions. This would help identify where priorities exist and what actions would be considered to be not only environmentally preferable, but cost-effective in the broadest sense.

The primary issue for policy options which affect buildings is the magnitude of first costs. This applies to new buildings and to building retrofits. For example, a home builder will not want to purchase more insulation material or more expensive heating equipment because this increases up-front expenses, liability, and also increases the cost of a home (which must be sold in a competitive market). Unless home buyers are aware of the long term savings and benefits of operating the more efficient home, they will not be willing to pay the higher initial cost. Therefore, the challenge is to identify the long-term savings and inform consumers of these savings. Moreover, there needs to be a much broader recognition of the total benefits of adopting a specific policy measure.

9.3 Commercial Sector

In Ontario, the commercial sector accounted for 12 percent of energy-related CO_2 emissions in 1990. The relatively small percentage is outweighed by the significant opportunities for CO_2 reduction in this sector.

In 1988, Canada had an average energy use value of about 2 GJ/m^2 for commercial floor space. This value is high compared to other industrialized countries such as the United States, where it is 1.1 GJ/m^2. The northeastern states have a climate similar to that of southern Ontario and have an energy intensity level of only 1.2 GJ/m^2[2.12]

One of the greatest barriers to energy efficiency in the commercial building sector is the "split incentive". As described for residential buildings, above, this refers to the builder and/or commercial building owners' desire to ensure that the least expensive building techniques and equipment are used, regardless of the long-term operating cost of the building. There is little incentive for a builder to reduce energy bills, because the builder does not pay them. Furthermore, there is no incentive for the owner, because building operating costs are passed on to the tenants. Unfortunately, the only party which benefits from improved energy efficiency measures has no say in the decision to incorporate them into a building. Heightened awareness of the energy component of rental costs may encourage consumers to seek lower rents or lower utility costs which would eventually influence the decisions about building energy.

Presumably this could be overcome by increasing general awareness of building operating costs among potential commercial tenants, as well as through market forces where the more efficient building will be more desirable to tenants.

Two general policy or program activities may be:

- increasing awareness of the cost-effectiveness of more efficient commercial buildings; and,
- the creation of a commercial (and residential) energy efficiency testing, training demonstration and education facility with joint private and public sector funding.

Other more specific policy measures to increase commercial building efficiency include: building code standards, procurement and retrofit programs, commercial building labelling and facilitation of market forces.

Building Codes

Until 1993, commercial buildings in Ontario were not subject to any energy efficiency standards and regulations. The 1993 Building Code amendments include the adoption of American Society of Heating, Refrigerating and Air Conditioning Engineers' ASHRAE 90.1 standard which sets minimum requirements for the energy efficient design of new commercial buildings. Implementation of the standard will lower energy use to about 1 GJ/m^2 in new commercial buildings, a 50 percent improvement over current levels.

Since the ASHRAE standard was developed for the United States, there is room for cost-effective improvements to this standard based on the conditions in Ontario.[13]

Policy options for the commercial building code include:

- o higher standards based on Ontario's climate;
- o enforcement of ASHRAE standards;
- o adoption of guidelines for solar heating;
- o adoption of guidelines for commercial cogeneration.

Procurement and Operations Policies

Governments and business can contribute significantly to energy efficiency improvements by developing policies and programs which ensure that only the most energy efficient products and building upgrades are purchased. Specifically:

- o provincial and municipal governments in Ontario could adopt energy efficiency procurement policies for buildings which they or their agencies own. This would bring the buildings up to or near existing codes and could be targeted to drive certain markets and to take into account full life-cycle costs of efficiency improvements. One option for achieving this and avoiding upfront capital cost to the government could be through energy performance contracting (EPC) with energy service companies (ESCOs);
- o businesses could adopt energy efficiency procurement and operations programs for their buildings, and encourage their suppliers and customers to do the same;
- o the Ontario government and Ontario Hydro could work together to increase efforts for energy efficient procurement and building retrofit programmes.

Commercial Building Labelling

Commercial Building Labelling could provide prospective tenants with information about the comparative energy performance of the space which they are considering leasing. This information is currently not easily available and can vary significantly from building to building. This initiative could encourage landlords to adopt energy efficiency measures since reduced energy costs could attract tenants, as well as increasing saleability.

- o The energy performance of commercial buildings could be rated in the same way as the proposed home energy rating system.

Fuel Switching and Renewables

A number of the similarities exist between the residential and commercial sectors with respect to the use of renewable energy and fuel switching. There are also several important distinctions where the commercial sector has advantages for efficiency gains.

Due to the relatively large, flat surface area on the roofs of many commercial buildings, there is an opportunity for cost-effective solar water heating to meet the hot water and low temperature steam demands of commercial buildings.

Commercial buildings which have hot water heating systems can also take advantage of the highly efficient diesel cogeneration. These small systems provide electricity and steam at total thermal efficiency in the 80 to 90 percent range, two or three times greater than conventional electricity production.

Renewable and fuel switching options for the commercial sector include:

- adoption of performance standards in the building code which encourage renewable technologies;

Market Forces

Some of the available efficiency potential in the commercial sector is being realized through market forces. This is the major sector for energy service companies (ESCOs). They are able to identify and implement very cost-effective efficiency measures which the customer pays for through reduced energy bills.

There are a number of private and public sector activities which may be able to assist the market place to maximize penetration and efficiency. For example:

- ESCOs could develop a self-regulating body to ensure uniform service delivery;
- governments and businesses could adopt energy performance contracting policies for building retrofits;
- ESCOs in partnership with governments could provide training and education support for energy efficiency contracting;
- governments and private sector could create shared capital pools for energy retrofits

9.4 CO_2 Reduction Potential

Commercial CO_2 emissions could be reduced by 46% (6 Mt) from 1988 to 2005 in the following scenario:[14]

- all new commercial buildings will use half the energy/m^2 of floor space as the existing stock of buildings by 2005;
- space heating needs in 50% of the commercial building stock are cut by 20% by 2005;

- high efficiency lighting retrofit in 75% of the existing building stock reduces electricity use from lighting loads by 60%;
- a reduction in energy use from plug load of 20% by 2005, through efficiency improvements in office equipment, computers, etc.;
- downtown Toronto buildings connected to the city's district heating system are cooled during the summer with cold lake water using a concept called Freecool.
- utilities could work with ESCOs to have them sell conservation to large energy customers, including municipal utilities;

Certain aspects of this scenario are conservative, given that it assumes a 52% increase in commercial floor space in Ontario between 1988 and 2005, which is unlikely considering the commercial vacancy rate in Toronto is approximately 35%.

9.3.1 Cost Implications

It is assumed that any measure adopted by the commercial sector would be economically attractive to the building owner and/or tenant. Very large savings can be achieved in this sector due to the relative inefficiency of existing building stock and commercial lighting, compared to what is available today. For example, one estimate is that energy savings in commercial lighting as high as 70 to 90 percent can be achieved at a cost of US$0.006/kWh [15], one-tenth the cost of the electricity.

Since all new commercial buildings will be built at double the efficiency of existing stock, the greatest opportunities for savings will be on retrofitting older buildings. Using ESCOs to undertake energy performance contracting, the efficiency gains to be made in the commercial sector ought to reduce first-cost and capital availability barriers.

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10.0 Appliances and Equipment

10.1 Introduction

Rather than divide policy options by sector, we have chosen to look at specific uses of energy which cut across residential, commercial and industrial sectors. Appliances and equipment include everything from toasters to large industrial motors.

Appliances and equipment can be subject to the same basic policy options as other areas described in this report. For example, the role of standards and regulations has been a particularly useful tool in the past and they will continue to play an important role.

There are also a number of creative market approaches to increasing the efficiency of appliances and equipment.

10.2 Standards and Regulations

Standard Setting Principles

There are risks and opportunities associated with taking a lead in standards development and standards setting. Standards development is generally costly, as is the research required to develop leading edge technologies. Moreover, unique standard development may be somewhat constrained by international trade agreements and the multinational nature of manufacturing. Since much of the production of electrical equipment in Canada is owned by multinational companies, research and decisions relating to production are often made outside Canada. On the other hand, there are a number of sectors where Canada has a lead in energy efficiency technology.

Ontario or Canada could perhaps select one or two areas where we can develop leadership in research, development and demonstration to push technology and industrial development in Ontario.

- Research would need to be undertaken in this area to determine which are the most promising technologies, possibly natural gas technologies such as fuel cells;

- a joint public-private energy efficiency research agenda could be developed, which would include priorities, funding mechanisms for research and technology commercialization.

Standards vs Incentives

Standards and regulations have the advantage of ensuring 100 percent penetration (or exclusion) of efficiency products into the market place. Standards, however, tend to address the lowest common denominator. Incentive programs, on the other hand, can be used to stimulate markets for leading edge efficiency products as well as helping to raise awareness of new products. Incentive programs are beneficial for filling in gaps currently not covered by standards and regulations or to lead the adoption and development of new products. A number of specific measures relate to the use of incentive programs, together with standards:

- incentive programs can be timed with and coordinated with standards and regulations implementation to maximize the market share of efficient equipment;
- research could be undertaken on the success and cost-effectiveness of standards vs incentives in achieving efficiency;
- provincial coordination of standards implementation across Canada may help to facilitate the adoption of standards as well as reducing the opportunities for dumping low-end products in jurisdictions without standards;
- incentive programs can be used to accelerate the retirement of slow turnover, inefficient products, linked to a standard for the higher efficiency replacement;

Efficiency Standards and Regulations

The Ontario Energy Efficiency Act (EEA) is the enabling legislation which the Ontario government uses to set minimum efficiency standards. The act applies primarily to residential "white goods", water heaters, furnaces, air conditioners, commercial lighting and small electric motors.

Two basic options exist with the Energy Efficiency Act to reduce CO_2 emissions. Standards for currently regulated products can be increased, or more products can be regulated.

Electric motors in the 1-200 hp range are the only industrial sector products regulated under the EEA, and do not come into effect until 1996. Motive power is the largest component of electricity consumption in the industrial sector, comprising, on average 75 percent of an industry's electrical consumption. Industrial drive power has also been identified as an area where major efficiency gains can be made. Energy, Mines and Resources estimates cost-effective energy savings of 20 percent for industrial drive-power.[1]

- performance standards could be developed which specify the use of variable speed drives for specific applications.

Compliance with energy efficiency standards is apparently becoming an increasing problem in Ontario. A couple of simple policy measures will help to ensure that sub-standard products are not being sold in Ontario:

- o tougher enforcement and more resources could be devoted to compliance;
- o standards non-compliance could be made a provincial offence so that Ministry of Environment and Energy inspectors can write "tickets" to offending retailers.

Equipment Labelling Programs

Equipment labelling programs, such as EnerGuide, are important tools to assist consumers in making informed choices with respect to the efficiency of the appliances they purchase. There are several measures which, if adopted, would help to make these programs more effective:

- o sales people in stores could receive better training on the meaning of provincial and federal energy efficiency labels;
- o provincial and federal labelling could be coordinated to reduce confusion and improve cost-effectiveness of program delivery;
- o bar coding information could be included on provincial labels to provide data collection for evaluating program effectiveness and fine tuning standards.

Procurement and Operations Policies

Similar to the measures described in Section 9, above, governments and business could adopt procurement programs to ensure that purchases of appliances and equipment are made in accordance with specific energy efficiency or CO_2 reduction objectives.

- o provincial and municipal governments could have energy efficiency procurement policies for appliances and equipment which exceed existing codes and are targeted to drive certain markets and to take into account long-term (10 or 20 year) paybacks for efficiency
- o businesses could adopt procurement policies and inform company purchasing staff of the long-term cost savings of energy efficiency products.

10.3 Market Approaches

Energy efficiency and environmental concerns are one of the driving forces behind marketing efforts for energy consuming products in Canada[2]. Energy efficient lighting, high efficiency gas furnaces and energy efficient computer equipment are a few examples of products being marketed on the basis of energy efficiency.

One can assume that where consumers are aware, they make reasonable decisions with respect to purchasing products that they believe will save them money and have less of an impact on the environment. Without accurate information and policies which support environmental decisions, consumers may not be able to make choices which are in their best interest.

- o governments, in partnership with utilities and business can play an important role by heightening consumer awareness of the relationships between energy consumption and climate change

The trend toward self-regulation and industry-wide standards is becoming more prevalent. The ISO 9000 standard, for example, is rapidly becoming an international standard guaranteeing quality. Protocols similar to ISO 9000 (such as TC 207) will likely be developed which incorporate environmental performance and energy efficiency standards.

These international industry standards have wide implications for the future of traditional government standards development.

- o businesses in Ontario could explore the opportunities for adopting energy efficiency standards that help push Ontario industry ahead of the competition in other jurisdictions.

The Ontario Green Communities Initiative stimulates local economies by providing economic activity and job creation through environmental initiatives. Energy and water conservation are two important aspects of this initiative.

- o utilities, governments and businesses could use the Green Communities Initiative to invest in energy efficiency retrofits and energy conservation measures throughout their community. Energy and water savings for customers and utilities could be tracked and a percentage of the savings could be returned to the program to make for an ongoing and self-sustaining community improvement program.

10.4 Impact of Existing Energy Efficiency Act Regulations

According to Ontario's Ministry of Environment and Energy, the existing regulations under Ontario's Energy Efficiency Act will reduce Ontario's energy consumption in the year 2000 by 23.5 PJ. The savings by fuel type are: 12.8 PJ for natural gas; 10.3 PJ for electricity; and 0.4 PJ for oil. As a result, Ontario's CO_2 emissions in 2000 will be reduced by 3372 kilotonnes.[3]

10.5 Cost Implications

Costs and benefits of equipment standards are difficult to assess accurately, for the same reasons as those cited for building code standards, described in Section 9, above. Examining the availability of appliances at different efficiency levels and reviewing prices for the appliances makes evident that appliances with higher efficiencies than stipulated in the EEA are readily available for a small increase in cost over the less efficient models.

Using life-cycle cost assessment for higher efficiency appliances, as opposed to payback periods, increases the cost-effectiveness of appliances and equipment.

The avoided cost for achieving the CO_2 reductions cited in Table 10.2, above, (standards development to date are factored in the cost) is approximately 0.05 cents per kWh.

ENDNOTES

1. Energy Mines and Resources, Remaining Energy Conservation Potential in Canada: Industrial Drive-power Case Study, 1990.

2. Bell, David, Technical Director Electrical and Electrotechnical Manufacturing Association of Canada, *pers. comm.*, 1994.

3. Memorandum to Jack Gibbons from Doug MacCallum of the Ontario Ministry of Environment and Energy, August 4, 1994.

Part C: Stabilization and Reduction Strategies

11.0 Possible CO_2 Stabilization and Reduction Strategies

As noted in Chapter 3, Ontario must reduce its forecast CO_2 emissions by approximately 8,700 - 20,000 kilotonnes (approximately 6-12%) and by approximately 56,000 kilotonnes (approximately 30%) respectively in order to: i) stabilize its CO_2 emissions, at its 1990 level, by 2000; and ii) reduce its CO_2 emissions by 20%, relative to its 1988 level, by 2005. Table 11.1 (page over) summarizes the options presented in this paper in terms of their percentage capability of complying with the reduction targets. The two final columns of Table 11.1 provide an estimate of how much an option could potentially contribute to either the stabilization target or the 20% reduction target (for example, option 8 in table 11.1, 500,000 new transit commuters could reduce carbon dioxide emissions by 600 kilotonnes; this would represent 7% of what is needed [8751 kilotonnes] to achieve stabilization in 2000).

There are at least four distinct CO_2 stabilization and reduction options that could be considered, namely:

1) A Pure Tax Strategy

- involves eliminating the existing tax subsidies for energy consumption and establishing a carbon tax;

2) A Tax and Carbon Quota Strategy

- involves eliminating the existing tax subsidies for energy consumption, establishing a carbon tax for all sectors except Ontario Hydro and energy-intensive industries, and controlling the CO_2 emissions from the sectors that are exempt from a carbon tax by CO_2 emissions quotas;

3) A Regulatory Policy Strategy

- makes the exclusive use of regulatory policy options; and

4) A Regulatory and Fiscal Policy Strategy

- makes use of a combination of fiscal (tax and government spending) and regulatory policy options.

The following sections briefly describe and evaluate the above-noted CO_2 stabilization and reduction strategies.

Table 11.1: Carbon Dioxide Reductions, Their Magnitude and Relation to Targets

Option	Sector / Industry / Population Involved	Nature of Instrument	Option Detailed on Page Number	Reduction Achievable	% amount that Option contributes to Stabilization	% amount that Option contributes to 20% target
1) Retail Sales Tax Extension to Energy	residential and commercial customers	Fiscal	19,20	1000 to 2000 kt in 2000 2200 to 4200 kt in 2005	11 - 23%	4 - 8%
2) End Motor Vehicle Subsidies	motorists, motor vehicle industry	Fiscal	20	not readily quantifiable		
3) Subsidy Diminishment for Ontario Hydro (43% Rate Increase)	electrical consumers	Fiscal	21	2900 to 5700 kt in 2000 6000 to 12000 kt in 2005	33 - 65%	11 - 21%
4) 100$ to 200$ Carbon Tax	all sectors and population	Fiscal	21-26	8751 kt in 2000 56059 kt in 2005	100%	100%
5) Carbon Quota Option A: Ontario Hydro & Other Electrical Generators	electrical industries	Regulatory	31-33	0 to 15600 kt in 2000 4575 to 16257 kt in 2005	0 - 172%	8 - 22%
6) Carbon Quota Option B: Large Industrial Energy Users	large industrial energy users	Regulatory	33,34	7900 kt in 2000 12700 kt in 2005 20755 kt in 2005	90%	23% 37%
7) Vehicle Stock Reduction: 10%	motor vehicle industry	Public Education / Fiscal / Regulatory	41	3200 kt in 2000 3800 kt in 2005	37%	7%
8) New Transit Commuters 100,000 500,000	transit industry	Public Education / Fiscal / Regulatory	41,42	120 kt 600 kt	1% 7%	0.2% 1%
9) Higher Fuel Costs	petroleum marketers motorists	Fiscal	45,64,65	4000 to 6000 kt	46 - 69%	
10) Higher Parking Charges	motorists, private businesses, municipal governments	Fiscal	45	supporting measure, option not readily quantifiable		
11) Road Metering and Charging	transportation sector	Regulatory / Fiscal	46	supporting measure, option not readily quantifiable		
12) Limiting Road Supply	transportation sector	Regulatory	47	4800 kt in 2005		9%
13) Urban Public Transit Improvements	transit users, transit industry	Fiscal	47,48	supporting measure, option not readily quantifiable		

Option	Sector / Industry / Population Involved	Nature of Instrument	Option Detailed on Page Number	Reduction Achievable	% amount that Option contributes to Stabilization	% amount that Option contributes to 20% target
14) Para-transit	transit, taxi industry	Fiscal / Market / Regulatory	49,50	supporting measure, option not readily quantifiable		
15) Inter-City Public Transit Improvements	transit users, transportation sector	Fiscal	450	supporting measure, option not readily quantifiable		
16) Auto Rental System Improvements	automobile rental industry	Market	51	supporting measure, option not readily quantifiable		
17) Bicycle Use to Reduce Motor Vehicle Kilometres Driven 5%	bicycle supply industry, cyclists	Fiscal / Suasion / Regulatory	51,52	1600 kt in 2000 1900 kt in 2005	18%	3%
18) Pedestrian Travel to Reduce Kilometres Driven 1%	small and local business	Public Education	52	320 kt in 2000 380 kt in 2005	4%	1%
19) Movement of Goods	local business	Suasion / Procurement Market	52	supporting measure, option not readily quantifiable		
20) Transportation Education	transportation sector	Education	52,53	supporting measure, option not readily quantifiable		
21) Car Pooling to Work	motorists	Public Education	53,54	100 to 500 kt	1 - 6%	0.2 - 0.9%
22) Urban Intensification	urban redevelopment industry	Public Education / Regulation	54	supporting measure, option not readily quantifiable		
23) Stabilizing the Vehicle Stock	motor vehicle industry	Fiscal / Regulatory	56	4800 kt in 2000 10700 kt in 2005	55%	19%
24) CAFC Standards	motor vehicle industry	Regulatory	57,58,67	3300 to 5150 kt in 2000 8800 to 13400 kt in 2005	38 - 59%	16 - 24%
25) Automotive Technological Improvements	motor vehicle industry	Market	59,60	5300 kt in 2005		10%
26) Consumption-based Tax / Rebate Scheme	motorists, motor vehicle industry	Fiscal	60-63	~4000 kt in 2000 ~10000 kt in 2005	46%	18%
27) Driver Behavioural Changes / Speed Limit Regulation	motorists	Regulatory / Public Education	63	supporting measure, option not readily quantifiable		
28) Removal of Inefficient Vehicles	motorists	Regulatory	63,64	supporting measure, option not readily quantifiable		

Option	Sector / Industry / Population Involved	Nature of Instrument	Option Detailed on Page Number	Reduction Achievable	% amount that Option contributes to Stabilization	% amount that Option contributes to 20% target
29) Reducing Motor Vehicle Kilometres Driven	motorists, fuel producers	Fiscal / Regulatory / Public Education	65	3200 to 9600 kt in 2000 3800 to 11500 kt in 2005	37 - 110%	7 - 21%
30) Cleaner Fuels / Drive Systems for Cars	fuel producers	Market	65-67	2580 kt in 2000 3100 kt in 2005	30%	6%
31) Utility Conservation Programmes: Gas Utilities Ontario Hydro	gas and electric utilities	Moral Suasion / Regulatory	72-76	10000 kt in 2000 21000 kt in 2005 4000 kt to 16000 kt in 2000 16000 kt in 2005	114% 46%-183%	38% 29%
32) Non-utility Generation:	electrical consumers	Regulatory / Market	79-81	8830 to 16370 kt in 2000 16800 kt in 2005	101 - 187%	30%
33) Building Code	builders, suppliers	Regulatory	85,86,91	not readily quantifiable		
34) Retrofitting	building trades, suppliers	Market	86	not quantified		
35) Building Demonstration Programs	building industry	Suasion / Procurement	87	supporting measure, option not readily quantifiable		
36) Fuel Switching	fuel producers	Market	87	not quantified		
37) Renewable Energy	energy producers	Market / Regulatory	88,89	not quantified		
38) Residential Retrofit Package	building trades, ESCOs, consultants, consumers	Regulatory / Fiscal	89	10000 kt in 2005		18%
39) Procurement and Operation Policies	government, large businesses	Regulatory / Procurement	92	not readily quantifiable		
40) Commercial Building Labelling	rental, building industries	Regulatory	92	supporting measure, not readily quantifiable		
41) Fuel Switching and Renewables	fuel and energy producers	Market	92	not quantified		
42) Commercial Retrofit Package	building trades, ESCOs consultants, tenants	Regulatory / Fiscal / Suasion	93	6000 kt in 2005		11%
43) Efficiency Standards and Regulations	appliance and equipment manufacturers	Regulatory	96-99	not quantified		

11.1 A Pure Tax Strategy

Under the pure tax strategy, Ontario's CO_2 emissions would be controlled by eliminating the existing tax subsidies for energy consumption (e.g., retail sales tax exemption for electricity, natural gas, and home heating oil; numerous subsidies for Ontario Hydro; road subsidies), and by establishing a carbon tax.

Under this strategy, 100% of the incremental revenues from the new taxes would be used to reduce the levels of existing taxes (e.g., the provincial sales tax, personal and corporate income taxes), thus this strategy would not increase the tax burden for the average Ontario resident or business.

However, there are at least four problems with a pure tax strategy:

1) If Ontario's major trading partners do not introduce a comparable carbon tax, an Ontario carbon tax could have a very negative impact on the competitiveness of Ontario's energy-intensive industries. Moreover, a decline in the output of Ontario's energy-intensive industries would not lead to a decline in global CO_2 emissions if the Ontario output is displaced by non-Ontario companies whose CO_2 emissions per unit of output are greater than or equal to those of Ontario manufacturers.

2) A pure tax strategy is unlikely to be politically acceptable since many voters do not believe that 100% of the new tax revenues would be used to reduce existing taxes.

3) Many people would view the exclusive reliance on higher energy taxes, to achieve Ontario's stabilization and reduction goals to be unfair since we live in a cold climate and many citizens do not have a viable public transit alternative to the car.

4) The pure tax strategy would deprive Ontario of the benefit of a number of regulatory options which could increase the economic well-being of the province (e.g., higher minimum efficiency standards for new homes, and energy consuming appliances and equipment).

11.2 A Tax and Carbon Quota Strategy

This strategy is similar to the first strategy except that the CO_2 emissions of Ontario Hydro and Ontario's energy-intensive industries would be controlled by CO_2 emission quotas (i.e., they would be exempt from the carbon tax).

This strategy is not subject to the first criticism of the pure tax strategy (noted above). However, it is subject to the second, third and fourth criticisms that apply to the pure tax strategy.

11.3 A Regulatory Policy Strategy

Alternatively, Ontario could control its CO_2 emissions solely by regulatory policy options. For example, Ontario could control its CO_2 emissions by:

i. establishing CO_2 emission quotas for Ontario Hydro and energy-intensive industries;
ii. establishing fuel efficiency standards for cars and light trucks;
iii. requiring Ontario's gas utilities to aggressively promote energy conservation and efficiency; and
iv. raising the minimum energy efficiency standards for new homes and energy consuming appliances and equipment.

For example, Ontario could stabilize its CO_2 emissions, relative to the 1990 level, by 2000 by simply requiring large industrial users to stabilize their emissions at their 1990 levels, and requiring Ontario Hydro to stabilize its emissions at its 1994 emission level.

Furthermore, Ontario could reduce its CO_2 emissions by 20%, relative to its 1988 level, by 2005 by:

i. establishing a corporate average fuel consumption standard of 5.0 litres per 100 km for cars and 9.2 L/100 km for light trucks;
ii. requiring large industrial users to reduce their emissions by 20% relative to their 1988 levels;
iii.requiring Ontario Hydro to reduce its emissions by approximately 50% relative to its 1990 level; and
iv. requiring Ontario's gas utilities to very aggressively promote energy conservation and efficiency.

However, a CO_2 reduction strategy which only uses regulatory policy instruments might not be in the overall best interests of Ontario for one or more of the following reasons:

1) It might impose too heavy a burden on Ontario's energy-intensive industries and hence make them uncompetitive.

2) Strict automobile fuel efficiency standards will reduce the cost per kilometre of operating a car. Hence, in the absence of higher gasoline taxes, a significant portion of the potential CO_2 benefits of more efficient cars may be offset by a rise in the average number of kilometres driven per car.

3) A pure regulatory strategy would not allow the Governments of Canada and Ontario to harmonize the tax bases for the GST and the provincial sales tax (i.e., by subjecting electricity, natural gas, and home heating oil to the provincial sales tax).

11.4 A Regulatory and Fiscal Policy Strategy

Under this strategy the best regulatory options could be combined with the best tax and government spending options to control Ontario's CO_2 emissions. For example, Ontario's CO_2 emissions could be controlled by the following options:

i. CO_2 emission quotas for Ontario Hydro and large industrial energy users;
ii. minimum fuel efficiency standards for cars and light trucks;
iii. the aggressive promotion of energy conservation and efficiency by Ontario's gas utilities;
iv. higher minimum efficiency standards for new homes and energy consuming appliances and equipment;
v. elimination of the provincial sales tax exemption for electricity, natural gas, and home heating oil; and
vi. higher gasoline taxes, higher taxes on parking lots, and user-pay charges for the use of Ontario's highways, and the ear-marking of the incremental revenues to subsidize public and bicycle transit.

Glossary of Term and Acronyms

ASHRAE - American Society of Heating, Refrigeration and Air Conditioning Engineers
CAFC Standards - Corporate Average Fuel Consumption Standards
CAFE Standards - Corporate Average Fuel Efficiency Standards
CCME - Canadian Council of Ministers of the Environment
CCTG - Climate Change Task Group
CHIP - Canadian Home Insulation Program
CIELAP - Canadian Institute for Environmental Law and Policy
COGGER - Canadian Options for Greenhouse Gas Emissions Reduction
DOE - Department of Energy (United States)
DRIVE+ - Demand-based Reductions in Vehicle Emissions + Improvements in Fuel Efficiency
EEA - Energy Efficiency Act (Ontario)
EMR - Energy, Mines and Resources
EPC - Energy Performance Contracting
ESCO Energy service company
FCCC - Framework Convention on Climate Change
GDP - Gross Domestic Product
GHG - Greenhouse Gases
GJ - Gigajoules
GNP - Gross National Product
GTA - Greater Toronto Area
HVAC - Heating, ventilation and air conditioning
L/100km - Litres per 100 kilometres
LPG - Liquid Propane Gas
MOEE - Ministry of Environment and Energy
NAICC - National Air Issues Coordinating Committee
NUG - Non-Utility Generation
OEB - Ontario Energy Board
OGWC - Ontario Global Warming Coalition
ORTEE - Ontario Round Table on Environment and Economy
PG&E - Pacific Gas & Electric
PJ - Picajoules
PV - Photovoltaics
TFC - Tax for Fuel Conservation
UN - United Nations